

EXTENDING DYSARTHRIA RESEARCH  
WITH A MEASURE OF COMMUNICATIVE EFFECTIVENESS

By

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To those who taught me to love learning

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Researchers often assume but have not shown that treatment effects obtained in clinic translate to success in an individual's societal participation. Testing this assumption in the field of motor speech disorders is impossible at present because a psychometrically sound measure of communication in societal participation does not exist. The best the profession can do is assess speech intelligibility, a valid and reliable measure of connected speech used to demonstrate change at the clinical level.

The Communicative Effectiveness Survey (CES) may be an instrument to extend dysarthria research into societal participation, however, as yet it has unknown psychometric properties.

We asked three experimental questions to study the face validity and construct validity of the CES:

- Does the CES differentiate individuals with dysarthria and Parkinson's disease (PD) from non-PD gender and mean-age-matched individuals?

- Do individuals with dysarthria and PD rate their CES higher than their significant others (SO) rate them?
- Do traditional measures of sentence intelligibility (SIT) and spontaneous speech intelligibility (SSI) predict changes in CES?

A convenience sample of 75 participants was divided into three groups of 25: individuals with dysarthria and (PD); non-PD group; and SOs of individuals with PD. The dependent variables were the CES (all groups), the SIT and SSI (PD group only).

Results showed that the non-PD group rated their CES significantly higher than did the PD group. The PD group rated their CES significantly higher than the SO group rated them. The multiple linear regression model for SIT and SSI as predictors of change in CES was not significant ( $F[2, 22] = 1.97, p = .163$ ). The model accounted for 15% of the variability ( $R^2 = .152$ ). A post hoc multiple linear regression analysis, adding measures of physical disability (Hoehn and Yahr [H&Y]) and dysarthria severity (DRS) was significant ( $F[4, 20] = 6.88, p = .001$ ), and 59% of the variability was accounted for ( $R^2 = .588$ ). H&Y was the largest ( $\beta = .599$ ) and only significant predictor of CES ratings ( $t = -2.19, p = .040$ ).

The results of this study added evidence to the face validity and the construct validity of the CES. However, to ensure that the CES is a valid and reliable measure of communication in societal participation more work needs to be done on the other types of validity and reliability.

## CHAPTER 1 INTRODUCTION

### **Statement of the Problem**

Researchers often assume but have not shown that the treatment effects obtained in the clinic translate to success in an individual's societal participation to fulfill life roles. Testing this assumption in the field of motor speech disorders is impossible at present because a psychometrically sound measure of communication in societal participation does not exist. The best the profession can do is assess speech intelligibility (a measure of connected speech), which has demonstrated its worth as a measure of change at the clinical level. Or we can measure perceptual, acoustic and physiologic changes in speech. However, if the goal of speech therapy is to enable a person to communicate more effectively to participate in his life roles (what some call functional communication), then measures of communication in societal participation are needed. One such measure that is under development is a measure of communicative effectiveness.

Models of rehabilitation such as the World Health Organization (WHO) International Classification of Functioning, Disability, and Health (ICF), provide us with a rationale for extending treatment (such as speech therapy) and rehabilitation research into the societal participation component. Conceptually we propose that extending research into the societal participation component of the ICF model requires a different measure called communicative effectiveness. We define communicative effectiveness as a person's ability to actively and efficiently get his message across successfully in his

home and community settings to fulfill life roles (Hustad, 1999; Lomas et al., 1989; Yorkston, Klasner, & Swanson, 2001).

Neurologic diseases such as Parkinson's disease often cause impairments including a class of speech disorders called the dysarthrias. The typical clinical and research approach to the dysarthrias is to measure and treat the signs of impairment, which can include sound imprecision, disturbed rate, reduced loudness and pitch variability. Dysarthria results in problems in verbal communication (speech) "due to paralysis, weakness, abnormal tone, or incoordination of the speech musculature" (Duffy, 2005). A principal measure of dysarthria treatment outcome is speech intelligibility, a measure based on the acoustic presentation of a series of increasingly complex speech productions that a listener can decode, from single words to complex sentences (Yorkston, 1996; Yorkston & Beukelman, 1981a, 1981b; Yorkston, Beukelman, & Traynor, 1984).

The tacit assumption of this approach is that changes in speech intelligibility will have equally positive influences on a person's communication to fulfill life roles; what the World Health Organization (WHO) International Classification of Functioning, Disability, and Health (ICF) identifies as the component of participation (WHO, 2001). However, studies report no clear one-to-one relationship between a speech intelligibility score and a person's communication success beyond the clinical treatment setting (Weismer & Laures, 2002; Yorkston, 1996).

As the population ages we expect the incidence of PD to increase worldwide (Van Den Eeden et al., 2003). It has been estimated that approximately 70% of individuals with PD eventually develop speech disorders that affect not only them but their families as well. (Parkinson's disease Society, 2004) Therefore it is important that we investigate

aspects of communication disorders that are pertinent to this group at the level where the difficulties are the most troublesome, in fulfilling their life roles—the ICF’s participation domain.

The Communicative Effectiveness Survey (CES) is being studied in our laboratory to serve as a measure of communication in the ICF societal participation component. The CES originated from an aphasiology questionnaire, the Communicative Effectiveness Index, developed by Lomas and colleagues (1989). Ball and colleagues (2004) reported on the psychometric properties of an instrument very similar to the CES (CETI-M) that they used to measure the communicative effectiveness of 25 individuals with amyotrophic lateral sclerosis (ALS) (one type of movement disorder that often results in motor impairments and dysarthria). Those authors demonstrated the usefulness of their communicative effectiveness measure (CETI-M) to identify social communication needs of persons with ALS and their significant others, people for whom traditional speech therapy is often contra-indicated (Ball et al., 2004). They also reported that the CETI-M showed psychometric properties including face validity and content validity for what today is classified as the participation component of the ICF. However, because the speech impairments of individuals with ALS make up only one subset of the dysarthrias, research is needed that includes individuals with other types of dysarthria as well. We chose to investigate one of those groups, individuals with hypokinetic dysarthria and Parkinson’s disease.

In a prior study we investigated the measurement properties of the Communicative Effectiveness Survey (CES) using a single-parameter model of item response theory called Rasch analysis. We conducted two analyses: first for 95 individuals with various

movement disorders and speech competency from normal to severe dysarthria; and second for 66 individuals with idiopathic PD and speech competency from normal to severe dysarthria. Rasch analysis gives information that can be compared to the traditional test-theory terms such as validity, reliability and responsiveness. Our results indicated that the CES demonstrated sufficient measurement properties including: the theoretical hierarchy matched the sample hierarchy of items (similar to face validity), individuals with movement disorders and arrange of speech competence endorsed the items on the survey in a predictable manner (similar to content validity, and there was high (.90) person-to measure correlation (comparable to Cronbach's alpha), similar to traditional measures of reliability of response (for both groups). The results were considered strong enough to prompt us to continue investigating its usefulness as a tool that we could use to measure Communication at the level of societal participation. We used the data from the earlier analyses to design this study to add further validity to the instrument for individuals with PD.

The goal of this study was designed to add evidence to the face validity, content validity and construct validity of the Communicative Effectiveness Survey for individuals with dysarthria and PD by accomplishing three specific aims.

### **Specific Aims**

- Specific aim 1: Determine if CES ratings differentiate normal speakers from dysarthric speakers with PD.
- Specific aim 2: Determine the difference in CES ratings by participants with dysarthria and PD and their CE ratings completed by significant others.
- Specific aim 3: Determine the relationship between two measures of speech intelligibility and CES ratings of participants with dysarthria and PD.

## Research Hypotheses

Based on the established specific aims, we developed three experimental hypotheses.

- Hypothesis 1: The CES ratings for 25 participants with dysarthria and PD will be significantly lower than CES ratings of 25 mean gender- and age-matched healthy participants.
- Hypothesis 2: The CES ratings of 25 participants with dysarthria and PD will be significantly higher than the CES ratings given to them by their significant others (SO).
- Hypothesis 3: When predicting sentence intelligibility score (SIT) from communicative effectiveness survey score (CES), spontaneous speech intelligibility score (SSI) accounts for a significant amount of the variation in SIT above and beyond the variation due to CES for individuals with dysarthria and PD. Likewise, when predicting SSI from CES, SIT accounts for a significant amount of the variation in SSI above and beyond the variation due to CES for individuals with dysarthria and PD.

## CHAPTER 2 LITERATURE REVIEW

To understand the development of our thesis that dysarthria research needs to be extended into the ICF societal participation component, we divided review of the literature into four sections which will include: a description of the components of World Health Organization's ICF and how they pertain to research and treatment of dysarthria; a brief summary of the state of the art in assessment and treatment of hypokinetic dysarthria (the dysarthria that results from Parkinson's disease); a review of the traditional treatment outcome measures of dysarthria; and an operational definition of communicative effectiveness; and a review of how the CES has been tested in other laboratories. The final section of the chapter gives the foundational evidence that the CES had sufficient measurement properties to continue investigating its validity as a measure of communication in societal participation for individuals with idiopathic PD and dysarthria.

### **World Health Organization International Classification of Functioning and Disability**

The WHO International Classification of Functioning, Disability and Health (ICF) is one of the models used in the rehabilitation literature (WHO, 2001). The ICF is a compelling conceptual model for two reasons. First, the ICF's biopsychosocial design attempts to integrate the most important aspects of both the medical model and the social model of functioning and disability. The ICF defines health-state as a bi-directional dynamic process involving the person with the disease/illness, which can be positively or negatively affected by contextual/ environmental and personal factors. It is now

recognized that a constellation of environmental and personal factors may positively or negatively impact health-state and functioning, regardless of the type or intensity of treatment received (Cardol et al., 2002; Jette, 2003; Keysor & Jette, 2001). Second, the ICF is a compelling model because it illustrates the complexities involved in planning and carrying out investigations and interventions to achieve and maintain optimum functioning of individuals in compromised health states (Brandt & Pope, 1997).

The ICF includes 2 components: body structures and functions; and activity and participation (previously know as the domains of impairment, handicap, and disability) (WHO, 2001). Activity is defined as a discrete task or action that a person executes. Participation is defined as a complex task that may require multiple sets of skills to complete. Chapter 3 of the ICF describes the activity and participation skills needed for communication. A communication activity for speech production is “producing words, phrases and longer passages in spoken messages with literal and implied meaning, such as expressing a fact or telling a story in oral language” (p. 134) (WHO, 2001). Communication for societal participation is defined as “holding a conversation: starting and sustaining an interchange of thoughts and ideas, carried out by means of spoken, written, sign or other forms of language, with one or more people one knows or who are strangers in formal or causal settings” (p. 135) (WHO, 2001). Impairment is the term used to denote a deficit in body structures and/ or body functions (i.e. paralysis of a body as a result of cerebral infarct). Activity limitations and participation restrictions are the terms used when an individual cannot successfully complete the delineated skills under the conditions defined by the ICF.

The inclusion of these domains, allows for the possibility of research to differentiate between an individual's capacity to perform an activity and his actual participation in fulfilling societal roles. However, there are now published reports by investigators that many different types of raters including healthcare providers and rehabilitation scientists have difficulty differentiating between activity limitation and participation restriction (Jette, Haley, & Kooyoomjian, 2003; Nordenfelt, 2003; Perenboom & Chorus, 2003). These reports provide initial evidence that the theoretical distinction between activity and participation may be more understandable than the concrete application of rating them in rehabilitation research, assessment, and treatment.

The science of rehabilitation is moving toward an integrated approach that includes consideration of performance, context of performance, and psychosocial issues thanks to conceptual models of enablement such as the ICF. Unfortunately, most studies of dysarthria have not kept up with the current advances in rehabilitation (Enderby, 2000). Rather, most studies of dysarthria are based on perceptual judgments, acoustic, and physiologic measures. Speech-language pathologists make perceptual judgments during an individual's speech evaluation. Perceptual judgments are typically made using a rating scale to judge the voice quality, pitch, loudness, prosody, intonation, hypernasality, and precision of articulation of speech. Acoustic measures include fundamental frequency, vocal intensity, maximum duration of phonation, semitone standard deviation. Physiologic measures include things such as forced vital capacity, maximum inhalatory pressure, and maximum exhalatory pressure (Ansel & Kent, 1992; Hammen & Yorkston, 1996; Kent, 2000; Kent & Read, 1992; Kent, Vorperian, Kent, & Duffy, 2003; Klasner, Yorkston, & Strand, 1999; Rosenbek & LaPoint, 1978). These kinds of measures are

related most directly to the body structures/functions component of the ICF (Enderby, 2000). Specifically, the ICF Body Structures and Functions Chapter 3 “Voice and Speech Structures/Voice and Speech Functions” describes the body structures and functions required to produce voice and speech.

On the other hand, the commonly used assessment of connected speech production, the Assessment of Intelligibility in Dysarthric Speech (AIDS), would be classified in the activity component (Ball et al., 2004; Yorkston & Beukelman, 1981a, 1981b; Yorkston, Beukelman, & Tice, 1996; Yorkston et al., 1984; Yorkston, Dowden, & Beukelman, 1992; Yorkston, Strand, & Kennedy, 1996). For example the ICF Activity/Participation Chapter 3 states that communication addresses receiving, and producing different forms of communication including words, gestures and signs, pictures, writing, and body language, along with using augmentative communication devices.

Although the ICF provides the framework for a more integrated rehabilitation approach in dysarthria research, such research has been hindered by an absence of valid and reliable tools for measuring communication beyond the body structure/function and activity components of the ICF. Pertaining to the hypokinetic dysarthria associated with PD, the bulk of the literature would be classified in the body structures/functions component of the ICF (WHO, 2001).

There is scant documentation of what impact, if any, hypokinetic dysarthria has on an individual’s participation in fulfilling his societal roles. However, according to Yorkston and colleagues (2001), “there remains an urgent need to develop measures that reflect the quality of communication participation in adults with acquired neurologic communication disorders” (p.136).

We do have an instrument that was developed to show change in communicative effectiveness of individuals with aphasia before and after treatment. That instrument is the Communicative Effectiveness Index (CETI). We suggest that the CETI has content validity as a measure of participation. The Communicative Effectiveness Index (CETI) items were developed from interviews that involved individuals with aphasia and their caregivers about the everyday speaking situations where individuals experienced decreased communicative effectiveness (Lomas et al., 1989). Additionally, the CETI was designed to show changes in communicative interactions in social situations for individuals with aphasia. The authors reported that individuals with aphasia demonstrated improved communicative effectiveness after therapy based on changes in ratings of communicativeness (Lomas et al., 1989). Of late the psychometric properties of the CETI-M (an instrument very similar to the CES) were reported based on the ratings of individuals with dysarthria and amyotrophic lateral sclerosis (Ball et al., 2004). These authors also presented evidence of the face validity of the CETI-M as a measure of communication in societal participation.

In conclusion, we suggest that the WHO ICF and other conceptually driven models of functioning and disability provide the rationale for an instrument that will measure an individual's communication to successfully participate in life roles. We do not have such an instrument at this time in the field of speech pathology. We suggest that the CES may be an instrument that was originally designed to be such a measure and that there is early evidence that it has usefulness for individuals with amyotrophic lateral sclerosis. We do not, however, know how individuals with PD would rate their communicative effectiveness on the CES.

### **Assessment and Treatment of the Dysarthria of Parkinson's Disease (PD)**

Any neurologic disease afflicting the bulbar system can result in a motor speech problem called dysarthria. Parkinson's disease (PD) is such a disease and the resulting motor speech problem is called hypokinetic dysarthria. Parkinson's disease can affect 500,000 people at any one time (Van Den Eeden et al., 2003). An estimated 70% of individuals diagnosed with PD experience dysarthria ranging from mild to severe over the course of the disease (Yorkston, Miller, & Strand, 2004). Dysarthria can affect the person as well as the speech. Consider this statement presented on the Parkinson's disease Society website: speech disorders:

can interfere with all aspects of communication and as a result there can be a great deal of unhappiness, frustration, and misunderstanding, not only for the person with PD but also for the significant other and the people the person comes into contact with (Parkinson's disease Society, 2005 <http://www.parkinsons.org.uk>).

Dysarthria is not a single speech disorder, but several different speech disorders. Duffy (2005) defined the dysarthrias broadly as:

the collective name for a group of speech disorders resulting from disturbances in muscular control over the speech mechanism due to damage of the central or peripheral nervous system. It designates problems in oral communication due to paralysis, weakness, abnormal tone, or incoordination of the speech musculature (p. 5).

Specifically, the hypokinetic dysarthria associated with PD has been identified based on the following perceptual characteristics: reduced intensity (monoloudness), reduced stress and intonation patterns (monotone, monopitch), abnormal voice quality, articulatory imprecision of consonants produced in rushed bursts of speech, and inappropriate or illogical pauses during speech (Adams, 1997; Darley, Aronson, & Brown, 1975; Duffy, 1995, 2005; Rosenbek & LaPoint, 1978; Yorkston et al., 2004).

Ramig and colleagues built a substantial body of literature showing the immediate and long term treatment efficacy of the Lee Silverman Voice Treatment (LSVT) for individuals with hypokinetic dysarthria and PD (Ramig, 1994, 1995; Ramig, Countryman, O'Brien, Hoehn, & Thompson, 1996; Ramig, Countryman, Thompson, & Horii, 1993; Ramig, Countryman, Thompson, & Horii, 1995; Ramig et al., 2001). Lee Silverman Voice Treatment is an intensive therapy (4 hours per week for 16 weeks and daily home practice) based on the theory that training maximum phonatory effort leads to increased vocal intensity that, in turn, generalizes to other speaking situations.

Ramig has reported that changes in one or more acoustic or physiologic measure (fundamental frequency, vocal intensity, maximum duration of phonation, semitone standard deviation, and forced vital capacity) and perceptual ratings (loudness, pitch, monotonicity) were significantly higher for individuals who received LSVT compared to those who received a treatment of respiratory effort at post-treatment, 12 months post-treatment, and 24 months post-treatment intervals (Ramig, 1994, 1995).

If we look at how the authors categorized their assessment tools with regard to the ICF components of body structures/functions and activity/participation, we see that self-ratings and family-ratings of the perceptual categories of loudness, monotonicity, and hoarseness were described as measures of functional communication. Ratings of speech intelligibility and conversational initiation were described as measures of activity limitations (Ramig, 1995). Finally, they categorized ratings on the Communication and Social Interaction subtests of the Sickness Impact Profile (SIP) as measures of functional outcome (Ramig et al., 1996; Ramig et al., 1995). The SIP (Bergner, Bobbitt, Carter, & Gilson, 1981; Gilson et al., 1975) is defined by its authors as a behaviorally-based

measure of sickness-related dysfunction, rather than a functional outcomes measure (Pollard & Johnston, 2001).

Ramig group's use of pre- and post-treatment self-report ratings as functional communication outcome measures bears review. Results of these self-report ratings for males and females in both treatment groups resulted in changes that were statistically significant for all perceptual measures (except loudness) including: monotonicity, hoarseness, intelligibility, and initiation of conversation. Self-ratings of loudness resulted in a time, treatment, gender interaction whereby males who received LSVT showed the greatest improvement. These results showed that from the patients' perspectives, both treatments resulted in improvement on all variables rated (except loudness) for a specific group of males and a specific group of females. On face value, these results added credence to the theorized variability of self-report ratings from individuals PD. For example, other authors reported that individuals with mild to moderate dysarthria and PD had reduced insight into their speech deficits (Antonius, Beukelman, & Reid, 1995; Yorkston, Bombardier, & Hammen, 1994).

Other considerations, however, may have to do with study methodology. The authors state that two speech-language pathologists administered treatment to all individuals and "worked closely together to ensure consistency and equivalent high effort and motivation across both forms of treatment" (p. 1234) (Ramig et al., 1995). It was reported that individuals were asked to complete self-rating forms at different intervals during and after the study. However, the authors do not report how the self-ratings were obtained (i.e., did the clinicians administer the self-report form, or were the clinicians present when the individual completed the form). The bias of participants trying to give

responses that pleased the clinicians may have been a confound to the results of this study.

Another possibility is that the variables were difficult for untrained individuals or their families to rate in the manner intended by the investigators. Unfortunately, in the reported comparisons of short-term (12 months) and long-term (24 months) results of the LSVT, Ramig et al., (1996) did not report self-ratings or family ratings of perceptual variables. If these self-ratings and family-ratings were used as outcome measures (comparing pre-treatment and post-treatment ratings) it would have been useful to our understanding about the effectiveness of the treatment from the subject's point of view (the functional perspective) to have the results of the same measures at 12 months and 24 months post-treatment.

The choice of a measure of sickness-related dysfunction, such as the SIP (Bergner et al., 1981), may also have affected their results. The SIP is a widely used measure of dysfunction related to sickness (Pollard & Johnston, 2001). Ramig and colleagues (1996) used two subtests of the SIP (Communication and Social Interaction) to measure functional improvement. Individuals who received LSVT rated a significant reduction of the impact of their illness (PD) on the communication subtest of the SIP (i.e. the affect that PD had on their communication was reduced), while the placebo treatment group rated no significant change in the impact of sickness on their communication immediately after treatment (i.e., the affect that PD had on their communication was unchanged). At 12 months post-treatment the significant change reported on the SIP by the LSVT group was not maintained, and the placebo group reported a significant increase in sickness impact on communication (i.e., the affect that PD had on their communication had

increased, communication was more difficult) (Ramig et al., 1996). No significant differences were found on ratings of the impact of sickness on social interactions (i.e. PD had no affect on their social interactions), for either group, at either time.

The results seemed contradictory because many of the social-interaction items required communication to participate in the social interactions, and one would expect that if communication had improved there would also be improvement in the social interaction items that pertained to communication. See Table 2-1 for examples of communication and social interaction items from the SIP.

Table 2-1. SIP communication and social interaction items

Communication Items	I do not speak clearly when I am under stress I have difficulty speaking, for example get stuck, stutter, stammer, slur my words I am having trouble writing or typing I react slowly to things that are said or done
Social Interaction Items	I am cutting down on some of my usual recreation and pastimes I am doing fewer community activities I am cutting down on the length of visits with friends I am doing fewer activities with groups of people

(Bergner et al., 1981)

Review of the examples of the items on the SIP showed that the communication items address behaviors we would classify in the ICF activity domain, while social interaction items address behaviors we would classify in the ICF participation domain. So although Ramig and colleagues (1995, 1996) used the SIP as an outcomes measure for societal participation, we suggest that their results showed that the LSVT was efficacious at the level of activity limitation, but not at the level of societal participation.

Studies by Ramig's group comprise the bulk of the treatment efficacy research for hypokinetic dysarthria. Along with the treatment efficacy data, the authors reported that the treatment (increasing vocal intensity) led to improved communication skills, which

led to improved quality of life for individuals with PD, though they provided no objective evidence. We need evidence to substantiate or refute those subjective observations. Ramig and colleagues did not report on the same measures in the study of treatment efficacy and treatment effectiveness. They provided only subjective observations regarding improved quality of life. With regard to treatment effectiveness they reported that the treatment was effective based on acoustic and perceptual measures although the SIP communication scale ratings were not maintained at either 12 months post-treatment or 24 months post-treatment (Ramig et al., 1996).

If the goal of speech therapy, for example LSVT, is to enable a person to communicate more effectively to participate in his life roles, measures of participation are needed. Presently treatment effectiveness is based on measures that are applicable to the clinical setting, but not to the social participation of individuals.

Evidence-based practice guidelines would suggest we should only administer those treatments that improve communication effectiveness in daily life or at the participation level. Unfortunately present measures focus on clinical efficacy versus participation effectiveness. The results of the LSVT literature point to the need for an instrument that can measure the communication of individuals at the level of societal participation. We propose that the CES is such an instrument.

### **Measurement in Dysarthria**

Kent (2000) reviewed the motor speech literature from its infancy to 2000, and stated that while there have been instrumental and technological advances, research has not moved far beyond the traditional studies of the classification and/or diagnosis of the dysarthrias. Darley, Aaronson and Brown (1975) presented a systematic description/classification of the dysarthrias by perceptual characteristics that continues to

be widely used in 2004. Their work was followed by a point-place model in which the anatomic places where important speech activities occur are numbered and assessed by perceptual judgments (Rosenbek & LaPoint, 1978). Beukelman and Yorkston (1977; 1979; 1981b) posited that while the work of both Darley and colleagues (1975), and Rosenbek and LaPoint (1978) were beneficial for classification and differential diagnosis of the dysarthrias, they did not give quantification of the person's overall speech production. Thus they developed and standardized a method for assessing speech intelligibility intended to give a measure of an individual's speech production of words and connected speech (Yorkston & Beukelman, 1981a; Yorkston, Beukelman et al., 1996; Yorkston et al., 1984).

Speech intelligibility at its simplest is defined as “the extent to which a listener understands the speech produced by individuals with motor speech disorders.” (p. 486) (Yorkston, Beukelman, Strand, & Bell, 1999). To obtain a speech intelligibility score, a naïve judge transcribes a tape-recorded sample of words and/or sentences without benefit of context or visual cues. The result is a percentage of intelligible words from total words possible (Yorkston & Beukelman, 1981b; Yorkston et al., 1984). Changes in speech intelligibility scores are traditionally reported to document treatment outcome (Yorkston, 1996).

Speech intelligibility is a recognized measure of speech production; however, procedures must be clearly controlled to minimize threats to the internal validity of a study. Such threats include listener familiarization (Hustad & Cahill, 2003; Spitzer, Liss, Caviness, & Adler, 2000), length of utterance (Spitzer et al., 2000), speaking task (Kempner & Van Lancker, 2002), medication fluctuations (Goberman & Blomgren, 2003;

Goberman, Coelho, & Robb, 2002; Larson, Ramig, & Scherer, 1994; Mawdsley & Gamsu, 1971; Quagliari & Celesia, 1977), practice (Inzana, Driskell, Salas, & Johnson, 1996), and attention (Ho, Iansek, & Bradshaw, 2002).

We know that sampling speech intelligibility under well-controlled circumstances will lead to a reliable measure of an individual's speech intelligibility, and can serve as a measure of treatment outcome per the work of Yorkston and Beukelman in their development of the Assessment of Intelligibility of Dysarthric Speech (AIDS) (Yorkston & Beukelman, 1981a, 1981b; Yorkston et al., 1984). However, authors report that there is not a one-to-one relationship between a speech intelligibility score and a person's communication success outside of the clinical treatment setting (Weismer & Lares, 2002; Yorkston, 1996).

Up to now, the lack of valid and reliable tools of functional communication (such as communicative effectiveness) has hindered the investigation of the relationship between speech intelligibility and functional communication. In a natural setting communicative interactions occur in a conversational context. Communication partners have the benefit of contextual cues, gestural cues, written cues, picture cues, and if needed, active conversational repair, to assist with communicative effectiveness. We concur with Ball et al., (2004) that we need valid and reliable measures to assess successful communicative effectiveness in the participation component. We propose that the Communicative Effectiveness Survey (CES) is such a measure.

### **Operationalizing Communicative Effectiveness**

We define communicative effectiveness as a person's ability to actively and efficiently get his message across successfully in his home and community settings to fulfill life roles, using whatever means of communication possible (Hustad, 1999; Lomas

et al., 1989). Furthermore, we conceptualize communicative effectiveness as a construct to be investigated in the participation domain of the ICF as have others (Ball et al., 2004; Hustad, 1999; Lomas et al., 1989; Yorkston et al., 1999).

Several authors have advocated the use of a rehabilitation model such as the WHO ICF in dysarthria research (Yorkston, 1996; Yorkston et al., 2001; Yorkston, Strand et al., 1996). However, only two recent studies reported on the disabling nature of dysarthria in a communicative context from the perspective of people with dysarthria. In the first, a qualitative study of 7 participants with multiple sclerosis and dysarthria, subjects' participation in social interactions and communication opportunities was severely affected although they had mild communication impairments based on their speech intelligibility scores (Yorkston et al., 2001). This is evidence that individuals focus their concerns at the level of participation restrictions, rather than impairment or activity limitations. The authors underscored the need for treatment goals focused on decreasing participation restrictions as the starting point of treatment rather than the ending point (Yorkston et al., 2001).

In a second study, Ball and colleagues (2004) reported that 25 individuals with ALS and their caregivers rated the communicative effectiveness of the person with ALS similarly (correlation between ratings from ALS speakers and their caregivers was  $r^2 = .87, p = .00$ ). In addition, both ALS speakers and their caregivers ranked the ten items on the CETI-M similarly with regard to level of difficulty (Wilcoxon signed ranks analysis, no significant differences). In addition, subjects also rated their communicative effectiveness in social situations more severely impaired although their speech intelligibility scores were as high as 90%.

These articles indicated that individuals with dysarthria associated with multiple sclerosis and ALS reported that they were restricted from participation in life roles due to their communication deficits (Ball et al., 2004; Yorkston et al., 2001). We do not have information of this sort for individuals with hypokinetic dysarthria and PD.

In summary, models of rehabilitation provide a rationale to begin developing treatments and outcomes measures at the level of societal participation. The state of the art in dysarthria treatment and outcomes is to use traditional, clinical measures of perceptual judgments, acoustic, and physiologic measures to show treatment efficacy. Those measures are often accompanied by a standard measure of connected speech called speech intelligibility. A speech intelligibility score has worth as a measure of change at the clinical level (termed activity component by the ICF), however it has not been shown that the effect obtained in the clinic translates to success in an individuals' participation in fulfilling his life roles (termed participation component by the ICF). It is imperative that research be done at the level of participation to identify what variables are critical to successful communication in that domain.

We propose that an instrument, such as the CES, which has demonstrated face validity in use with individuals with aphasia and individuals with dysarthria and ALS, may be such an instrument. However, the CES has been an instrument with unknown psychometric properties relative to individuals with other kinds of dysarthria and neurogenic disorders, such as those with dysarthria and Parkinson's disease.

We did a series of Rasch analyses to study the measurement properties of the CES before using it as a measure in the current study. The next section describes the

development of the CES and the results pertinent to its usefulness as a measure of societal participation for individuals with PD.

### **Development of the Communicative Effectiveness Survey (CES)**

Lomas and colleagues (1989) published a report on the development, validity and reliability of the Communication Effectiveness Index (CETI). To establish face validity for the instrument they enlisted individuals with aphasia and their spouses to generate items for the instrument. Next they tested the CETI using two groups of individuals; one group (n =11) still recovering with aphasia; and one group (n =11) stable with chronic aphasia (>12 months post-CVA). The authors reported the following internal validity scores: internal validity was high based on Cronbach's alpha = .90; test-retest reliability interclass correlation = .94 (95% C I = .87 to .91) and moderate inter-rater reliability interclass correlation =.73 (95% CI = .62 to .81). In addition, construct validity was determined using Spearman rank correlation coefficients between the CETI and three measures of aphasia. Their results indicated that the CETI showed a change in communicative effectiveness pre- and post-treatment for individuals with aphasia. We performed a post hoc analysis of power and effect size ( $t = 3.68$ ,  $df = 20$ ,  $d = 1.57$ ; 95% CI =  $.6 \leq 1.57 \leq 2.5$ ) to determine the statistical rigor of the instrument. Power of .94 for effect size of .8 indicated adequate statistical power of the results, although the sample size was small.

Yorkston et al., (1999) modified Lomas and colleagues' (1989) CETI from 14 to 8 items to be used by individuals with dysarthria. Their first modification of the CETI was to delete the items that pertained to language that did not pertain to individuals with motor speech disorders. Next, they involved individuals with dysarthria in the item selection process. The apparent usefulness and face validity of the instrument without the

necessary statistical analyses was the impetus for two stages of Rasch analysis to establish the measurement characteristics of the CES.

Rasch analysis, a single-parameter model of item response theory, was used to determine the measurement properties of the CES using computer software called WINSTEPS Ministep (Linacre, 1991). Rasch analysis is designed to provide an investigator with information about the important constructs of measurement, such as the initial content validity of the instrument, reliability of responses of the participants, unidimensionality of items, along with how well the items fit together to define a theoretical construct (such as communicative effectiveness). In addition, Rasch analysis transforms ordinal data (counts) into interval data, which results in a log-linear measure of item difficulty, and person ability calibrated on a single scale (Bond & Fox, 2001; Rasch, 1980; Wright, 1997; Wright & Linacre, 1989). Finally, Rasch analysis generates information on ceiling and floor effects, indicators of whether or not the instrument had a sufficient level of difficulty to accommodate the range of the population the instrument was designed to measure (Veloza & Peterson, 2001).

In the first stage of analysis to determine the measurement characteristics of the CES a speech-language pathologist blind to the purpose and hypotheses of the study administered the CES, an eight-item, seven-point interval scale, to 95 individuals with movement disorders (diagnosed by a movement disorders specialist from the University of Florida Movement Disorders Center). The individuals with movement disorders had speech competencies ranging from normal to severe dysarthria. Table 2-2 gives the demographic data for the group.

Table 2-2. Demographics of participants in two Rasch analyses of CES ratings

	All Movement Disorders)	PD only
Mean age	62.6 (range 18-89)	66.5 (range 49-87)
Gender distribution	58% Male, 42% Female	64% Male, 36% Female
Diagnosis	PD 70%, Dystonia 10%, Other 20%	PD 100%
Speech competence	Normal to severe dysarthria	Normal to severe dysarthria

We hypothesized that the CES would show measurement properties sufficient for use as an instrument to measure the communicative effectiveness of people with movement disorders, as it had with individuals with aphasia. Rasch analysis was used to determine the measurement properties of the instrument by converting the ordinal data to interval data using WINSTEPS, a computer software program (Linacre, 1991). See Table 2-3 for a summary of the Rasch analysis.

The results of the first analysis showed that the CES had sufficient measurement properties, along with initial construct validity and response reliability, to continue investigating its usefulness as a measure of communicative effectiveness for individuals with movement disorders and a wide range of speech competence. The only exception to our findings was that individuals used a 5-point rating scale more effectively than a 7-point scale. The 5-point scale was used for all further analyses.

The purpose of the second stage of analysis was to analyze the measurement properties of the CES for individuals with PD (70% of the original sample). See Table 2-2 for the group demographics. We hypothesized that the CES would show similar measurement properties for individuals with PD, as it showed for individuals with various movement disorders. The results showed that the second analysis were indeed similar to the first, with the exception that individuals with PD used a 4-point rating scale more effectively than the 7-point scale. See Table 2-3 for a summary of the second Rasch analysis.

Table 2-3. Results of two Rasch analyses of CES ratings

	All movement disorders	PD only
Sample size >50 <sup>a</sup>	N=95	N=66
Person-to-Measure Correlation*	.90	.90
Unidimensionality (MnSq=1 Ideal)		
In-fit Statistics - Persons	MnSq = .99	MnSq = .99
In-fit Statistics – Items	MnSq = .98	MnSq = .98
Levels of Difficulty <sup>b, c</sup>	3.13 statistically significant levels of ability	3.05 statistically significant levels of ability
Actual Item hierarchy agreement with theoretical item hierarchy	7/8 (±1 item) Hierarchy of items agreed with the hierarchy proposed a priori	6/8 (±1 item) Hierarchy of items agreed with the hierarchy proposed a priori
Redundancy of items	1 Talks when upset rated the same difficulty as talks in a noisy environment	1 Talks when upset rated the same difficulty as talks in a noisy environment
Reliable use of rating units	Used a 5 point rating scale more reliably than a 7 point scale	Used a 4 point rating scale more reliably than a 7-point scale

<sup>a</sup>(Linacre, 1994), <sup>b</sup>(Wright & Stone, 1979), <sup>c</sup>(Veloza & Peterson, 2001) \*Comparable to Cronbach's alpha

To determine that the 4-point rating scale was more effective than the 5-point rating scale, we used a set of 8 guidelines presented by Linacre (2002). We applied the guidelines to the summary of measured steps to determine the effectiveness of the 4-point rating scale. See Table 2-4. Our results met 7 of 8 of the criteria that Linacre established as essential for rating scale use. See Table 2-5 for those results. The exception was that there was not a regular distribution in our category count.

Based on both populations analyzed, the CES showed sufficient measurement properties, along with initial face validity, content validity, and reliability of response (based on person-to-measure correlation, similar to Cronbach's alpha), to continue

investigating its usefulness as a tool to quantify communicative effectiveness of individuals with PD and a wide range of speech competence.

Table 2-4. Summary of measured steps 4-point rating scale - PD sample

Category	Average	Expected	OUTFIT	Step	Coherence	Coherence	Zone	Zone	
Count	Measure	Measure	MnSq	Calibration	M→C%	C→M%	From	To	
*1, 2	*3	*3	*4	*5	*6	*6	*7, 8	*7, 8	
			(<2.0)	(>1 logit)	(>40%)	(>40%)	(>1.4)	(<5.0)	
1	28	-4.02	-4.09	1.03		72%	46%	-Inf.	-4.50
2	179	-1.07	-1.04	1.03	-4.48	73%	75%	-4.50	.49
3	166	1.95	1.94	.89	.57	64%	72%	.49	4.00
4	87	4.47	4.45	1.04	3.91	78%	64%	4.00	+Inf.

Note: \*Number identifies pertinent guideline in Table 2-5

Table 2-5. Summary of CES 4-point Rating Scale Characteristics of PD Sample

	Guideline	Measure Stability	Measure Accuracy	Description of this sample	Inference for next sample
Pre.	Scale oriented with latent variable	(E) MET	(E) MET	(E) MET	(E) MET
1	At least 10 observations of each category	(E) MET	(H) MET		(H) MET
2	Regular Observation distribution	(H) UNMET			(H) UNMET
3	Average measures advance monotonically with category	(H) MET	(E) MET	(E) MET	(E) MET
4	OUTFIT mean-squares less than 2.0	(H) MET	(E) MET	(H) MET	(H) MET
5	Step calibrations				(H) MET
6	Ratings imply measures, and measures imply ratings		(H) MET		(H) MET
7	Step difficulties advance by at least 1.4 logits				(H) MET
8	Step difficulties advance by less than 5.0 logits	(H) MET			

(Linacre, 2002) Note: (E) = Essential; (H) = Helpful, Blank areas = not applicable to the guideline

## CHAPTER 3 DESIGN AND METHODS

This study was designed to test the face validity, content validity, and construct validity of the CES as a measure of societal participation for individuals with dysarthria and PD. To accomplish that goal we designed a prospective study with mixed statistical design.

To test Hypothesis 1 a case-control, one-directional paired samples t-test,  $\alpha = .05$  was used to investigate whether the CES ratings of healthy community-dwelling speakers were significantly higher than the CES ratings of speakers with dysarthria and PD. To test Hypothesis 2 a one-directional dependent samples (familial blocking) t-test,  $\alpha = .05$  design was used to investigate whether the CES ratings of 25 participants with dysarthria and PD was significantly higher than the CES ratings given to them by their significant others (SO). To test hypothesis 3, a multiple regression analysis was used to determine the relationships between the CES and the two measures of speech intelligibility of speakers with dysarthria and PD.

The study required recruitment of three groups of subjects. The Parkinson's disease group designated PD, included individuals diagnosed with PD who also had dysarthria. The non-PD group designated NO, included individuals with no existing neurologic injury or disease and no dysarthria, who were matched on gender and mean-age to the PD group. The significant others group designated SO, included the significant

others of the individuals in the PD group. Significant other was defined as the person the PD individual identified as a primary communication partner.

### **Participants**

We enrolled 25 participants in each of three groups for a total of 75 subjects, based on an a priori power analysis for a one-tailed t-test using  $\alpha = .05$ , and power = .8. (Faul & Erdfelder, 1996). All participants were community-dwelling volunteers recruited from the University of Florida, Department of Neurology Movement Disorders Clinic, PD support groups, or elder community centers.

For all subjects, exclusion criteria included a reported history of neurologic, psychiatric, or language deficit, Mini-mental State Exam (MMSE) of less than 23 (Folstein, Folstein, & McHugh, 1975), Apathy Scale less than 14 (Starkstein et al., 1992), non-reader, non-English speaker, unable to follow directions due to hearing loss, less than 18 or more than 90 years of age. Individuals with PD also had to have a Hoehn & Yahr Staging for Parkinson's disease (H&Y) stage between 1 and 4. The H&Y is a staging instrument that is used in PD research which assesses physical ability. An example of a stage 1 item is symptoms are inconvenient but not disabling. An example of a stage 5 item is requires constant nursing care (Hoehn & Yahr, 1967). See Appendix B for all of the items on the scale. The participants also had to have a rating between 1 and 4 on the Dysarthria Rating of Severity (DRS). The DRS is a scale that rates the severity of dysarthria from stage 1, no detectable speech disorder, to stage 5, no functional speech (Yorkston et al., 1999). The healthy individuals and significant others were excluded if they had a history of a speech impairment. Table 3-1 gives the complete listing of inclusion and exclusion criteria for each group.

Table 3-1. Inclusion/exclusion criteria for study participants by group

Group	Inclusion Criteria	Exclusion criteria
PD n=25	Diagnosis of PD > 6 months Pharmacologically stable Can ID on/off movement cycles Hoehn & Yahr Staged 1-4 <sup>a</sup> MMSE $\geq$ 23 <sup>b</sup> Apathy Scale $\leq$ 14 <sup>c</sup> Dysarthria Functional Limitation Stage 1- <sup>4d</sup> Functional sentence reading skill Native English speaker Hearing acuity sufficient to follow directions Visual acuity sufficient to read large print Community dwelling 18 to 90 years old	History of other neurologic, psychiatric, or language deficits. Hoehn & Yahr staged $>4^a$ MMSE $< 23^b$ Apathy Scale $>14^c$ No dysarthria <sup>4</sup> Cannot read Non-English speaker Severely HOH Visually impaired Non-community dwelling No SO, or SO who is unwilling to participate $<18$ and $>90$ years old
NO n=25	No diagnosed PD MMSE $\geq 23^b$ Apathy Scale $\leq 14^c$ No Dysarthria Functional sentence reading skill Native English Speaker Hearing acuity sufficient to follow directions Visual acuity sufficient to read large print Community dwelling 18 to 90 years old	History of PD, other neurologic, psychiatric, speech, or language deficits MMSE $<23^b$ Apathy Scale $> 14^c$ Cannot read Non-English speaker Severely HOH Visually impaired Non-community dwelling $<18$ and $>90$ years old
SO n=25	No history of neurologic, psychiatric, speech, or language deficits MMSE $\geq 23^b$ Apathy Scale $\leq 14^c$ Functional sentence reading skill Native English Speaker Hearing acuity sufficient to follow directions Visual acuity sufficient to read large print Community dwelling 18 to 90 years old	History of neurologic, psychiatric, speech, or language deficits MMSE $<23^b$ Apathy Scale $>14^c$ Cannot read Non-English speaker Severely HOH Visually impaired Non-community dwelling $<18$ and $>90$ years old

<sup>a</sup>(Hoehn & Yahr, 1967) <sup>b</sup>(Folstein et al., 1975), <sup>c</sup>(Starkstein et al., 1992), <sup>d</sup>(Yorkston et al., 1999)

## **Recruitment**

### **Parkinson's Disease Group**

The Research Coordinator at the UF Movement Disorders Center (UF MDC), Gainesville, FL, who was trained to identify and recruit subjects for clinical trials in PD according to standards established by the NIH, approved a query of the UF MDC Database to identify individuals who met the study eligibility criteria to participate in our study (based on IRB-approved Informed Consent #416-2002). The Principal Investigator (PI) made the initial contact with potential participants. If the individual indicated a willingness to participate, the PI conducted a telephone screening to ensure that the individual met the inclusion/exclusion criteria. If the individual met the inclusion/exclusion criteria, an appointment was scheduled to obtain informed consent, perform the screening, and if appropriate, perform the study.

### **Non-PD Group**

Participants were recruited by the PI through responses to an IRB-approved printed flyer distributed to communities of older individuals. When a participant responded, the PI conducted a telephone screening to determine whether or not the participant met the inclusion/exclusion criteria for the study. If the individual met the inclusion/exclusion criteria an appointment was scheduled to obtain informed consent, perform the screening, and if appropriate, data collection.

### **Significant Other Group**

One of the eligibility criteria for the subjects with PD was that they had a significant other who was also willing to participate in the study. If the PD subject had a significant other willing to participate, a telephone screening was conducted with the

significant other at the same time the PD participant was contacted. Appointments for the PD participant and SO participant were scheduled for the same time.

### **Sample Demographic Data**

Using the inclusion/exclusion criteria listed in Table 3-1, and the described recruitment procedures, the 75 individuals were recruited into the study. The demographic data resulted in the following group compositions. The PD group was comprised of 25 individuals with dysarthria and PD, 14 males and 11 females. Their average age was 70.3 years (range 60-84 years,  $SD = 6.29$  years). See Table 3-2 for individual demographics.

The non-PD group was made up of 25 individuals, 14 males and 11 females. Their average age was 70.4 years (range 44-79 years,  $SD = 8.69$  years). See Table 3-2 for demographics of the NO group.

The SO Group was made up of 25 individuals, 10 males and 15 females. SOs were the spouses of individuals with Parkinson's disease in 21 of the 25 cases (84%). The other four participants included one sibling, two children, and one primary communication partner. See Table 3-2 for the demographics for the SO group.

### **Informed Consent**

The PI obtained informed consent for all seventy-five subjects, using the procedures established and approved in IRB#276-2004. The PI had received all of the required training in the proper procedures for obtaining informed consent and protecting the individual's health care information for both HIPAA and NIH compliance.

### Screening Measures

The inclusion and exclusion criteria established to control the threats to the external validity of the study required that participants complete a short screening battery prior to completion of the study. These measures and the possible threats to validity included:

- Mini Mental State Examination (MMSE). Cognitive deficits including dementia are typically associated with the overall severity of PD, and may be part of other diseases and aging as well. A short cognitive screening was chosen to control for the unreliable responses that might result from someone with diminished cognitive skills in all three groups. The MMSE is widely recognized as a quick screening tool that gives a gross measure of a person's cognitive skills (Folstein et al., 1975). We adhered to the MMSE's established cutoff score of  $\leq 23$  as an indicator of impaired cognition. If the participant obtained a score of 23 or less he/she was excused from further participation in the study.

Table 3-2. Demographic data for all groups

Group Participant	PD Group		NO Group		SO Group	
	Age	Gender	Age	Gender	Age	Gender
01	76	M	66	F	62	F
02	69	F	79	M	59	F
03	69	M	66	F	67	M
04	75	M	77	M	74	F
05	72	M	62	F	64	F
06	68	F	73	M	42	M
07	69	M	72	F	66	F
08	66	F	77	F	67	M
09	63	M	74	F	63	F
10	62	M	73	M	55	F
11	77	F	69	F	75	M
12	69	F	64	F	74	M
13	60	M	68	M	57	F
14	68	M	67	F	66	F
15	73	M	73	M	70	F
16	74	M	73	F	70	F
17	68	F	49	M	70	M
18	65	F	44	M	57	F
19	69	M	79	M	69	F
20	60	F	77	M	62	M
21	84	F	77	M	85	M
22	71	F	77	M	72	M
23	84	M	71	M	75	F
24	69	M	78	M	67	F
25	77	F	75	F	51	M

- Apathy Scale.** An apathy rating was included because there is evidence that apathy may occur in individuals diagnosed with PD (with and without the presence of depression) (Marin, 1990; Starkstein et al., 1992). Apathy may preclude successful participation in life roles (the domain we intended to investigate in our study). Depression, common to individuals with PD, is routinely recognized and treated in the UF Movement Disorders Center; therefore a depression screening was not included in this screening battery. Apathy is defined as a lack of motivation that is not attributable to diminished level of consciousness, cognitive impairment, or emotional distress (Marin, 1990; Starkstein et al., 1992). The scale used a cutoff score of >14. See Appendix C for the Apathy Scale.
- Hoehn and Yahr Staging for Parkinson’s disease (H&Y).** We determined that the study would include individuals between H&Y stage 1 and stage 4 to meet the criteria that they be community-dwelling (Hoehn & Yahr, 1967). The H&Y is a five-stage scale designed to rate the disability associated with Parkinson’s disease. The stages range from one to five, with one being the mildest (mild unilateral symptoms, inconvenient but not disabling, friends notice changes in posture, locomotion and facial expression) and five being the most severely disabled (complete invalidism, constant nursing care required, cannot walk or stand). See Appendix B for the complete scale.
- Dysarthria Rating of Severity (DRS).** We determined that the study would include individuals who had stage 1 dysarthria severity (speech problems and increased effort to speak noticeable to the individual), through stage 4 dysarthria severity (severe dysarthria, minimal speech intelligibility and frequent communication breakdowns). The DRS is a 5-stage model that clinicians can use to rank the reported and observed severity of dysarthria of individuals with PD (Yorkston et al., 1999). If an individual with PD was observed (and self-reported) to have normal speech, he was excused from participating in the study. Table 3-3 describes the DRS in detail.

Table 3-3. Dysarthria Rating of Severity

Stage	Description
Stage 1: No detectable speech disorder	Individuals who place high demand on communication will report changes in speech performance Complaints include sense of increased effort to speak
Stage 2: Obvious speech disorder with intelligible speech	Changes in voice: reduced loudness, reduced pitch variability and unsteady voice Complaints include difficulty speaking in specific communication contexts, such as a noisy environment
Stage 3: Reduction in speech intelligibility	Frequently asked to repeat Imprecise oral articulation Limited range of oral movements Rushes of speech with abnormal placement of pauses

Table 3-3. Continued

Stage	Description
Stage 4: Natural speech supplemented by augmentative techniques	Natural speech alone is no longer functional Frequent communication breakdowns Severe dysarthria with minimal speech intelligibility
Stage 5: No functional speech	Unable to speak at all Requires augmentative and assistive communication devices

(Yorkston et al., 1999)

### Dependent Measures

- **Communication Effectiveness Survey (CES).** The CES is the 8-item, 4-point equal interval scale developed in our laboratory. The CES showed initial measurement properties that suggested it would be a useful measure of change in communicative effectiveness of individuals with the dysarthria of PD. See Appendix A for the CES.
- **Sentence Intelligibility (SIT)** of the Assessment of Intelligibility in Dysarthria Speech (AIDS). The AIDS has standardized instructions for administration, along with established validity, and reliability (Yorkston & Beukelman, 1981a, 1981b; Yorkston et al., 1984). It is a measure of connected speech intelligibility elicited by asking a participant to read a set of sentences aloud.
- **Spontaneous Speech Intelligibility (SSI).** Kempler & Van Lanker (2002) showed that a speech intelligibility measure based on a reading sample resulted in significantly higher speech intelligibility scores than scores derived from a spontaneous speech samples of individuals with the dysarthria of PD, although many other investigators have shown that spontaneous speech intelligibility tasks result in significantly higher scores because listeners can derive more from the context of connected speech (Hustad & Beukelman, 2002; Hustad & Beukelman, 2001; Hustad & Cahill, 2003) Because of these conflicting results and because intelligible, spontaneous speech is the ideal outcome of speech therapy we added a measure of spontaneous speech intelligibility to our study. Each individual in the PD group was asked to talk for one minute about the place he/she was born after completing the SIT task.

### Procedures

#### Screening Procedures

Once a telephone screening confirmed the individual's eligibility to participate in the study, an appointment was set up at the sight of the participant's choice: home, VA Speech Pathology Clinic, or Shands Speech and Hearing Clinic. Informed consent was

obtained prior to the start of every study. It was obtained in the privacy of the individual's home or in a private treatment room where the participant could ask and answer questions confidentially.

After individuals signed the informed consent, the MMSE and Apathy Scale were administered. In addition the individuals diagnosed with PD received the H&Y staging and the DRS rating. The PI administered and scored all screening instruments.

Individuals who did not pass the screening were thanked for their time and excused.

Individuals who passed the screening continued on to participate in the study.

### **Dependent Measure Collection Procedures**

The experiment took place in a quiet room of the participant's choosing. Seventy-one participants chose to have the study conducted in their home. The remainder completed the study in the clinic

For all participants with PD, the experiment began 30 minutes after they had taken their medications or were in an "on" medication cycle, and ended 30 minutes before they were due to take their medication again or were in an "off" medication condition. We chose to assess participants in the PD group in an "on" medication cycle to obtain optimal speech intelligibility scores to compare with the communicative effectiveness ratings, recognizing that when individuals are in an "off" medication cycle speech intelligibility would be decreased. For the participants without PD the study was scheduled at their convenience.

All participants completed the CES independently after receiving verbal and written instructions. After the CES was completed every subject was asked to give his/her impressions about the instrument. The PI noted those impressions. NO and SO groups were excused after the debriefing.

Following completion of the CES, the PD group completed the SIT by reading 10 sentences that were 14 words in length. Twenty-five unique sets of 10 fourteen-word sentences were developed from the 100 14-word sentences presented in the AIDS to control for listener familiarity (Yorkston et al., 1984). Research Randomizer, a web-based random number generator was used to obtain the 25 unique sets of numbers (Urbaniak & Plous, 1997. <http://222randomizer.org>).

After the sentence intelligibility task was completed each PD participant generated a one-minute spontaneous speech intelligibility (SSI) sample based on the directions, “I would like you to talk to me for one minute about the place you were born and grew up. Please keep talking until I tell you to stop.”

### **Scoring Dependent Measures Procedures**

Three native English speakers who had no hearing loss (based on self-report) transcribed the Sentence Intelligibility (SIT) and Spontaneous Speech Intelligibility (SSI) samples. The transcribers were given both printed and verbal instructions from the AIDS for transcribing the samples. Transcribers had no familiarity with or access to the sentence stimuli used. As stated above, sentences were randomized for each participant to decrease the transcribers’ familiarity with the sentence intelligibility samples. The PI scored all SIT and SSI transcripts for intelligible and unintelligible words, per AIDS instructions (Yorkston & Beukelman, 1981a). The SIT and SSI score used for statistical analysis was an average of the scores of the three judges.

### **Data Collection Methodology**

The following methods were used to collect, store and transcribe the dependent measures:

- Published AIDS manual instructions for test administration and sample collection were followed (Yorkston et al., 1984).
- A headset noise-resistant microphone (TS031), positioned 2 cm from the speaker's mouth captured the speech samples.
- Microsoft MS Sound Recorder system contained in the Dell Inspiron 8600 Laptop Computer was used to record the speech in PM format, at 48.000 kHz, 16 Bit, stereo at 187 kb/sec.
- Background noise was < 30 dB-A measured by a sound level meter throughout recording. The sound level meter was calibrated prior to each recording.

Each subject was seated in an upright position, and the microphone was positioned.

Each subject received the following instructions in an effort to minimize reading errors:

“Please read the sentences to yourself one time. When you are ready, I will ask you to say the number behind the period and then read the sentences in your usual speaking voice. Please pause between each sentence.” Individual samples were saved to the computer hard drive, using a patient identification number and date. Recording and transcription parameters were the same as for the SIT. The speech samples of the 25 PD individuals were recorded onto three high fidelity CD's for transcription purposes. The transcribers used “sound” computer software and free field listening in a quiet setting with the listening volume set at a comfortable level to transcribe the samples. Their handwritten responses were returned to the PI for scoring. To ensure that the recordings were of sufficient quality, the three judges were asked to rate the quality of the speech recording on the CD's they received as excellent, good, fair, and poor. All three rated the recording quality as good.

### **Inter-rater Reliability**

Three judges transcribed the sentences and the spontaneous speech samples of the 25 individuals with dysarthria and PD. To assess the reliability of three judges' ratings,

Cronbach's  $\alpha$  was used to compare the variation of ratings for a particular judge in relation to the co-variation in ratings for all three judges. For intelligible words on the SIT task, the corrected judge to total correlations were .94, .96, and .86 for the three judges respectively yielding a standardized reliability of  $\alpha = .97$ . For unintelligible words on the SIT task, the corrected judge to total correlations were .84, .94, .82 yielding a standardized reliability of  $\alpha = .95$ . For intelligible words on the SSI task, the corrected judge to total correlations were .98, .96, and .91 for the three judges respectively yielding a standardized reliability of .98. Finally, for unintelligible words on the SSI task, the corrected judge to total correlations were .69, .61, and .55 for the three judges respectively yielding a standardized reliability of .83. Table 3-6 shows the results of the test for inter-rater reliability. To assess accuracy of scoring, a third party blinded to the study's purpose transcribed five randomly selected SIT and SSI samples. Accuracy of the transcriptions was 96% agreement between the PI and the third party.

Table 3-4. Inter-rater reliability

Task	Judge 1	Judge 2	Judge 3	Standardized Reliability
SIT intelligible words	.94	.96	.86	$\alpha = .97$
SIT unintelligible words	.84	.94	.82	$\alpha = .95$
SSI intelligible words	.98	.96	.91	$\alpha = .98$
SSI unintelligible words	.69	.61	.55	$\alpha = .83$

Note: SIT=Sentence Intelligibility; SSI=Spontaneous Speech Intelligibility

### Data Analysis Plan

SPSS was used to produce descriptive statistics and the following inferential statistical tests:

- Hypothesis 1: The CES ratings for 25 participants with dysarthria and PD will be significantly less than CES ratings of 25 mean gender- and age-matched healthy participants. This hypothesis was tested using a one-tailed dependent samples *t-test* with the Type 1 error rate set at  $\alpha = .05$ .

- Hypothesis 2: The CES ratings of 25 participants with dysarthria and PD will be significantly larger when compared to the CES ratings given to them by their significant others (SO). Due to the dyadic relationship between the speakers and significant others, this hypothesis was tested using a one-tailed dependent samples *t*-test with the Type 1 error rate set at  $\alpha = .05$ .
- Hypothesis 3: When predicting sentence intelligibility score (SIT) from communicative effectiveness survey score (CES), spontaneous speech intelligibility score (SSI) accounts for a significant amount of the variation in SIT above and beyond the variation due to CES for individuals with dysarthria and PD. Likewise, when predicting SSI from CES, SIT accounts for a significant amount of the variation in SSI above and beyond the variation due to CES for individuals with dysarthria and PD. This hypothesis was tested using one-directional multiple regression and comparison of squared semi-partial correlation coefficients. Type 1 error rate set at  $\alpha = .05$ . The dependent measure was the CES, regressed on SIT and SSI scores.

## CHAPTER 4 STUDY RESULTS

- **Hypothesis 1.** The CES ratings for 25 participants with dysarthria and PD will be significantly less than CES ratings of 25 gender- and mean-age-matched healthy participants.

### Results of Testing Hypothesis 1

This hypothesis was tested using a one-tailed dependent samples *t*-test with the Type 1 error rate set at  $\alpha = .05$ . A paired-samples *t*-test was used to analyze the mean difference between the PD group and the NO group. The paired-samples test was justified by prior matching of participants between conditions on gender and mean age. The per comparison error rate was controlled at  $\alpha = .05$ . The correlation between groups was .083 and was not significantly different from zero ( $p = .69$ ). Healthy individuals (NO group) had significantly higher CES ratings ( $M = 28.68, SD = 2.82$ ) than participants with dysarthria and PD ( $M = 23.24, SD = 4.82$ ) with a mean difference of 5.44 between groups,  $t(24) = -4.70, p < .001$ . The 95% confidence interval around the mean difference between groups was 3.05 and 7.83. These data give a measure of construct validity to the CES. See Figure 4-1.

- **Hypothesis 2:** The CES ratings of 25 participants with dysarthria and PD will be significantly higher when compared to the CES ratings given to them by their significant others (SO).

### Results of Testing Hypothesis 2

This hypothesis was tested using a one-tailed dependent samples *t*-test with the Type 1 error rate set at  $\alpha = .05$ . This analysis compared the mean difference on the CES ratings for individuals with Parkinson's disease (PD group) and the significant others'

(SO Group) CES ratings of the individuals with PD. Although there was a moderate correlation between group ( $r = .69$ ), the relationship was not significantly different from zero. The results of the  $t$ -test indicate that the PD group participants had significantly higher CES ratings ( $M = 23.24$ ,  $SD = 4.82$ ) than their CES ratings given by the significant others (SO group) ( $M = 21.64$ ,  $SD = 5.80$ ) with a mean difference of 1.60,  $t(24) = 1.864$ ,  $p = .037$ . See Figure 4-2.

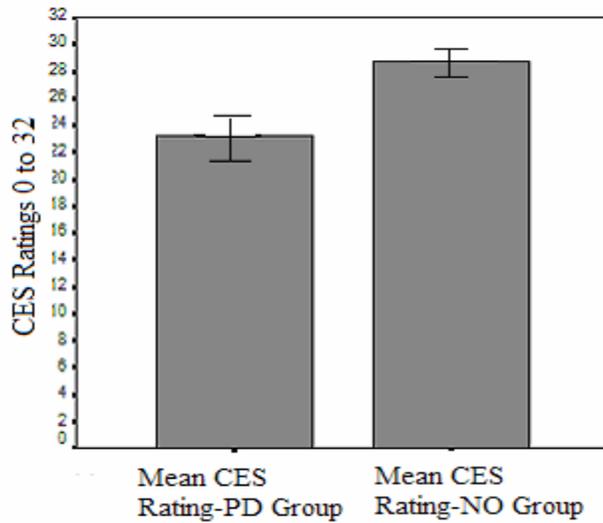


Figure 4-1. Comparison of means for PD and NO groups

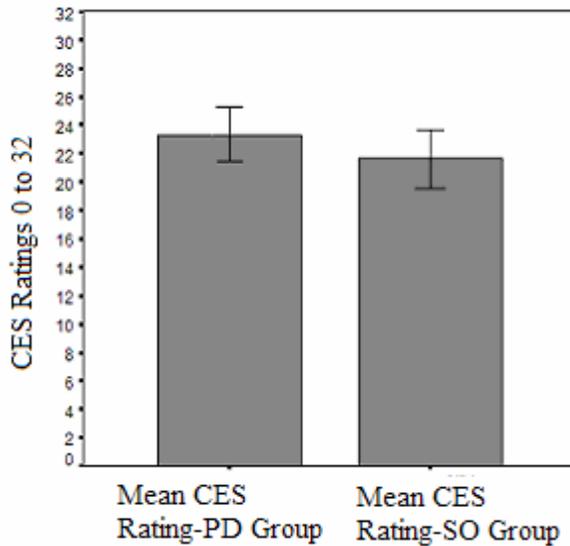


Figure 4-2. Comparison of means for PD and SO groups

- Hypothesis 3:** When predicting sentence intelligibility score (SIT) from communicative effectiveness survey score (CES), spontaneous speech intelligibility score (SSI) accounts for a significant amount of the variation in SIT above and beyond the variation due to CES for individuals with dysarthria and PD. Likewise, when predicting SSI from CES, SIT accounts for a significant amount of the variation in SSI above and beyond the variation due to CES for individuals with dysarthria and PD. This hypothesis was tested using one-directional multiple regression and comparison of squared semi-partial correlation coefficients to determine the relationships among the three measures. The dependent measure was the CES, the independent measures were the SIT and SSI scores. The multiple regression formula for this hypotheses was:  $CES = a + b_{sit}X_{sit} + b_{ssi}X_{ssi}$ .

### Results of Testing Hypothesis 3

Standard multiple linear regression analysis was performed using SPSS REGRESSION to determine the regression coefficients for CES, SIT and SSI. Assumptions were tested by examining normal probability plots of residuals and scatter plots of residuals versus predicted residuals. No violations of normality, or linearity were found. SPSS REGRESSION gives the regression coefficients  $\beta$ ,  $\beta$ -intervals,  $R^2$ ,  $F$  and  $p$ -values for the regression analysis. The full model  $CES = 2.94 + 47.27(SIT) - 25.46(SSI)$  was not significant,  $F(2, 22) = 1.97, p = .163$ .  $R^2 = .152$ , indicated that SIT and SSI accounted for only 15% of the variability in the observations. Table 4-1 gives the statistical data used in the regression model.

Table 4-1. Summary of variables SIT and SSI contributing to change in CES

Model	Unstandardized Coefficients		Standardized Coefficients	$t$	Sig	95% Confidence Interval	
	$\beta$	Std. Er.	$\beta$			Lower Bd.	Upper Bd.
(Constant)	2.94	16.01		.18	.86	-30.24	36.14
Avg. % SIT	47.27	27.16	.60	1.74	.10	- 9.06	103.50
Avg. % SSI	-25.45	28.80	-.30	-.88	.39	-85.18	34.27

Note: CES=Communicative Effectiveness Survey; SIT=Sentence Intelligibility; SSI=Spontaneous Speech Intelligibility

The partial correlation coefficients ( $\beta$ ) indicated that approximately 15% of the variance of SIT and SSI (11.6% and 3% respectively) was accounted for in the observations, leaving 85% of the variance unaccounted for. This result could be

attributed to random variability or it could indicate that we did not account for other variables that affected CES ratings. This result led to the following post hoc analyses.

### Post Hoc Analyses

In attempting to discover what other variables contributed to changes in CES ratings, a review of mean CES ratings by H&Y indicated that the PD group rated decreases in CES in relation to increased physical disability and increased dysarthria severity. We felt that post hoc analysis of these severity data was warranted to understand how individuals with dysarthria and PD rated their communicative effectiveness in relation to the severity of their physical deficits and the severity of their dysarthria. See Figure 4-3.

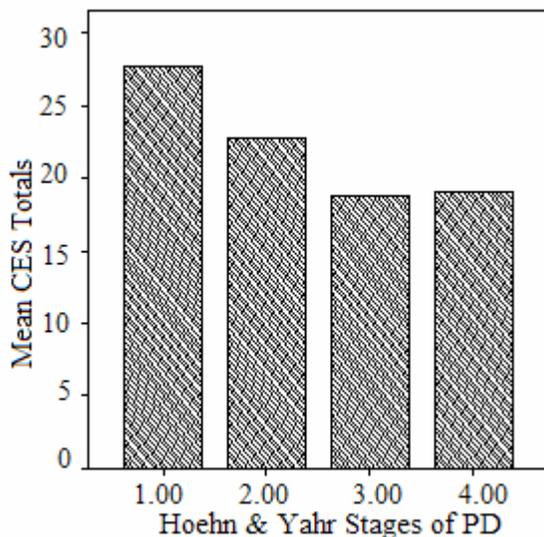


Figure 4-3. CES ratings for H&Y stages of PD

We began our post hoc analysis by reviewing our sample characteristics. First, we noted that our sample was skewed toward individuals with less severe physical disability, based on the H&Y ratings ( $M = 2.08$ ,  $SD = .996$ , range 1-4) (where 1 is mild and 5 is total invalidism). Although it was skewed, the sample met the necessary assumptions for statistical tests used including linearity, and normality (test of kurtosis was not

significant). The same held true for the DRS ( $M = 2.16$ ,  $SD = .62$ , range 1-3) (where 1 is very mild and 5 is no usable speech). See Figure 4-4. Finally, both sentence intelligibility (SIT) and spontaneous speech intelligibility (SSI) scores neared the ceiling of 100% intelligible (SIT [ $M = 94.2\%$ ,  $SD = 6.10\%$ ], and SSI [ $M = 95.4\%$ ,  $SD = 5.78\%$ ]). See Table 4-3 for descriptive statistics.

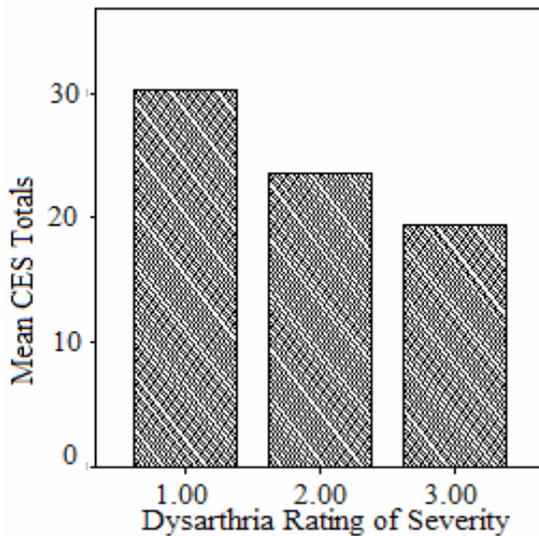


Figure 4-4. CES ratings for ratings of dysarthria severity

Standard multiple linear regression analysis was performed between CES (dependent variable) and the SIT, SSI, H&Y, and DRS using SPSS REGRESSION model  $CES = a + b_{sit}X_{sit} + b_{ssi}X_{ssi} + b_{h\&y}X_{h\&y} + b_{drs}X_{drs}$ . Assumptions were tested by examining normal probability plots of residuals and scatter plots of residuals versus predicted residuals. No violations of normality, or linearity were found. Table 4-4- gives the complete statistical data for the multiple regression analysis of CES, SIT, SSI, H&Y and DRS.

Table 4-2. Descriptive statistics for CES, SIT, SSI, H&amp;Y &amp; DRS

Measure	Mean	Standard Deviation	Number
CES Total	23.24	4.82	25
Average %SIT	.94	.06	25
Average %SSI	.95	.06	25
H&Y	2.08	.99	25
DRS	2.16	.62	25

Note: CES=Communicative Effectiveness Survey; SIT=Sentence Intelligibility; SSI= Spontaneous Speech Intelligibility; H&Y=Hoehn & Yahr Staging of Parkinson's disease (Hoehn & Yahr, 1967); DRS=Dysarthria Rating of Severity (Yorkston et al., 1999)

Table 4-3. Summary of variables SIT, SSI, H&amp;Y, and DRS contributing to change in CES

Model	Unstandardized Coefficients		Standardized Coefficients		t	Sig	95% Confidence Interval	
	B	Std. Er.	Beta				Lower Bd.	Upper Bd.
(Constant)	48.98	15.66			3.13	.005	16.32	81.64
Avg. % SIT	21.04	20.92	.27		1.01	.327	-22.60	64.68
Avg. % SSI	-37.02	27.71	-.44		-1.08	.104	-82.31	8.27
H&Y	- 2.72	1.24	-.56		-2.19	.040*	- 5.30	- .13
DRS	- 2.13	1.81	-.28		-1.17	.255	- 5.91	1.66

Note: CES=Communicative Effectiveness Survey; SIT=Sentence Intelligibility; SSI= Spontaneous Speech Intelligibility; H&Y=Hoehn & Yahr Staging of Parkinson's disease (Hoehn & Yahr, 1967); DRS=Dysarthria Rating of Severity (Yorkston et al., 1999)

The full model was significant ( $F[4, 20] = 6.88, p = .001, R^2 = .588$ ), and 59% of the variability in the CES was accounted for by the revised model. Analysis of the standardized coefficients (beta) showed that the H&Y variable was significant ( $t = -2.19, p = .040$ ) in this model and accounted for the largest portion of variance of all the variables. It was followed by the SSI, which approached significance ( $t = -1.08, p = .10$ ). These results suggested that as individuals declined in physical ability, we could predict a decline in their communicative effectiveness (participation component measure) as well, although their mean speech intelligibility scores (impairment component measure) remained high. This result adds evidence to the content validity of the CES as a measure of communication in societal participation.

### **Participant Feedback**

After subjects had completed the CES they were asked to respond to three questions, about the survey, and were free to answer or not. The questions were: 1) Overall, what is your impression of the CES? 2) Based on your experience, as a person with dysarthria and PD or the significant other of a person with dysarthria and PD are there other social speaking situations we should add to this survey? 3) Is there any other information about your communicative effectiveness that you think other healthcare professionals should know? The PI noted their comments on a debriefing form as they were talking. The PI asked for clarification if a comment was unclear. Of the 50 who participated in the study 25 gave comments during the debriefing other than “I thought it was fine” or “I wouldn’t add anything.” See Appendix C for a listing of the comments given by both individuals with dysarthria and PD, and their significant others.

In general, participants appreciate the brevity of the survey. They also reported that the survey tapped most of their daily communication situations. Suggestions for added items included: speaking when fatigued, speaking when off meds versus on meds, speaking when there is increased noise in the home, speaking when anxious, rather than angry or upset, speaking when engaged in a physical activity, speaking outdoors, speaking to a group, speaking when on the spot, and speaking for a long period of time.

In summary, we were able to accept Hypothesis 1 and Hypothesis 2. The results of Hypothesis 3 testing were more complex and required post hoc analysis to discern the salient predictors of CES. We were unable to accept our hypothesis that SIT and SSI would be significant predictors of change in CES ratings. Post hoc analysis revealed that the only significant predictor of change in CES ratings (based on our model SIT, SSI, H&Y, and DRS) was the H&Y, a measure of physical disability, followed by

spontaneous speech intelligibility. The contributions of these results to the field of dysarthria assessment, treatment, and research will be discussed in the next section.

## CHAPTER 5 DISCUSSION

We began this study by proposing that a measure of communication in the ICF societal participation component was needed for the field of motor speech disorders because although researchers often assume that the treatment effects obtained in the clinic translate to success in an individual's societal participation to fulfill life roles, they have not often shown it. It is impossible to investigate the phenomenon of communication in societal participation at this time because a psychometrically sound measure of communication in the societal participation component does not yet. We proposed that the Communicative Effectiveness Survey, a survey which measures communicative effectiveness in 8 everyday speaking situations, may serve as a measure of communication in societal participation, based on the literature, and our early foundational work in analyzing the measurement properties of the CES

The purpose of this study was to investigate three types of validity, face validity, content validity, and construct validity, of the CES for individuals with dysarthria and PD. The results of this study, their contributions to the dysarthria literature, and their implications for the future direction of research needed will be discussed first. The study limitations will be discussed next. We will end the discussion by describing ways to improve the CES, based on input from the study participants.

### **Hypothesis 1**

McHorney described different types of validity that must be addressed in survey development (McHorney et al., 2002). Some of those types of validity include ecological

validity, social validity, construct validity, and clinical validity, what others call construct validity (Cook & Campbell, 1979; Maxwell & Delaney 2004; Shadish, Cook, & Campbell, 2002). We presented the results of two analyses that showed foundational evidence for the content validity and face validity of the CES for individuals with PD and a wide range of speech competence in Chapter 2. The purpose of Hypothesis 1 was to investigate another aspect of validity, construct validity (specifically known-group construct validity), which is the ability of a measure to discriminate between groups with and without disease. The result of the test of Hypothesis 1 showed that CES ratings were significantly higher for healthy, community-dwelling individuals (NO group) than they were for community-dwelling individuals with dysarthria and Parkinson's disease (PD group) matched for gender and mean age.

There are many other components of construct validity that remain to be investigated for the CES. Questions that require further investigation include whether or not the CES ratings are sensitive to: 1) differences among individuals with PD with different levels of functional ability; 2) differences among individuals with PD with different levels of dysarthria severity; 3) differences between individuals with dysarthria and PD and individuals with PD only, 4) differences between CES ratings when individuals with PD are in "on" and "off" medication periods, 3) differences between pre- and post-treatment, and 4) differences that occur as the disease progresses.

Although the NO group (healthy, community-dwelling individuals) rated their CES significantly higher than the PD group, they did not judge their communicative effectiveness very effective 100% of the time ( $M = 28.68$ ,  $SD = 2.82$ ). Based on this finding, we propose that there are factors other than speech that contribute to judgments

about communicative effectiveness. Several factors mentioned by participants included: feeling ill at ease when speaking with a stranger or at a social event, feeling self-consciousness when speaking, and the hearing acuity of communication partners. Determining what factors, other than speech, contribute to communicative effectiveness is an area that requires further investigation.

### **Hypothesis 2**

It has been documented that individuals with PD underestimate their difficulties, or are not aware of the severity of their deficits (Marsden, Parkes, & Quinn, 1981; Yorkston et al., 1994; Yorkston et al., 2004). Reasons for these misperceptions have been hypothesized to occur because of dementia (Bodis-Wollner, 2003) and frontal executive dysfunction (Ho et al., 2002). However there is an emerging literature that suggests that individuals with PD have sensorimotor deficits that contribute to a mismatch between their actual performance and their judgment of performance (Abbruzzese & Berardelli, 2003; Bodis-Wollner, 2003; Ho, Bradshaw, Iannsek, & Alfredson, 1999). One example of this deficit pertinent to the LSVT (discussed earlier) is that individuals with PD perceive the loudness of their voice differently than age-matched individuals without PD (Abbruzzese & Berardelli, 2003).

There is also literature that showed that caregivers of individuals with chronic diseases rated those individuals significantly more disabled than the individuals rated themselves (Andresen, Vahle, & Lollar, 2001; Doyle et al., 2004; Duncan et al., 2002; Segal & Schall, 1994; Sneeuw, Aaronson, deHaan, & Limburg, 1997). Hypothesis 2 was designed to investigate the question of the differences between the ratings of communicative effectiveness of individuals with dysarthria and PD and the CES ratings that their significant others gave them. The results of the test of Hypothesis 2 showed

that individuals with dysarthria and PD rated their communicative effectiveness significantly higher than the significant others rated them. Our results add to the evidence in the respondent literature that individuals with PD rate their performance higher than do their significant others. However, with regard to the motor speech literature, our results from Hypothesis 2 differed from those of Ball and colleagues (2004), who reported that individuals with ALS and their caregivers did not have significantly different ratings on the CETI-M (a survey very similar to the CES). We suggest that the difference in our results lends further evidence to the literature that found individuals with PD do not (or unable to) recognize their communication deficits.

Our results indicated that obtaining information from the individual with the communication disorder alone might not give researchers and clinicians the most accurate information about the individual's communicative effectiveness. Our evidence holds clinical importance for training the communicative dyad, rather than the individual with dysarthria and PD alone. This is consistent with the findings of others in the field who work with individuals with PD and motor speech disorders (Hustad, 1999; Hustad, Beukelman, & Yorkston, 1998; Yorkston et al., 1994; Yorkston et al., 2004).

If the goal of treatment is improved communicative effectiveness for improved participation in life roles, and there is a significant difference between the communicative dyad's ratings of communicative effectiveness (i.e., for the individual with dysarthria and PD) then training the communicative dyad should begin at the earliest stage of treatment rather than waiting until close to discharge. Such training would provide the clinician, patient, and significant other an opportunity to try to reach agreement about what has occurred during treatment and what more needs to be done. However, we need evidence

to demonstrate the benefit of such a treatment paradigm. A future research project could evaluate the differences in CES ratings between individuals with dysarthria and PD and significant others who received treatment of the dyad, compared to a group where the individual with dysarthria and PD received treatment individually and the significant other received the traditional family education information.

Our research was not designed to determine whether the difference found between ratings of the PD group and the SO group was due to decreased insight, increased frontal dysfunction, or the proxy effect. In establishing our inclusion/exclusion criteria we attempted to control for depression (clients from the MDC are routinely treated for depression), dementia (MMSE), and apathy (Apathy Scale). However, we did not address the possibility that other sorts of frontal executive dysfunction could be present. An area for future investigation would be to determine what role frontal dysfunction (if it is present) contributes to the CES ratings of individuals with dysarthria and PD. This kind of research would be an example of what the World Health Organization envisioned for rehabilitation research when conceptualizing the ICF (WHO, 2001). The WHO ICF recommends research that spans the entire model, body function and structure (identifying frontal dysfunction), activity limitations (identifying the deficits that result from frontal dysfunction), and participation restrictions (identifying the difficulty completing life roles because of the frontal dysfunction).

### **Hypothesis 3**

The speech intelligibility literature has documented a number of threats to the internal validity of a study that uses speech intelligibility as a dependent variable. Such threats include listener familiarization (Hustad & Cahill, 2003; Spitzer et al., 2000), length of utterance (Spitzer et al., 2000), speaking task (Kempler & Van Lancker, 2002),

medication fluctuations (Goberman & Blomgren, 2003; Goberman et al., 2002; Larson et al., 1994; Mawdsley & Gamsu, 1971; Quagliari & Celesia, 1977), practice (Inzana et al., 1996), and attention (Ho et al., 2002). We attempted to control for these threats when we developed Hypotheses 3, by stipulating how our speech samples would be obtained, who would transcribe them, what tasks would be used, when the speech samples would be collected (i.e., when the individual was in the “on” state of medications). In addition, we stipulated the level of practice we would let the speakers do before recording the speech samples. Finally we attempted to control for attentional deficits by conducting the study in the quietest room of an individual’s home. However, the results of Hypothesis 3 were not as we had hypothesized. Neither SIT nor SSI accounted for a significant portion of the variance in the CES in our initial multiple regression analysis.

Review of the data led us to postulate that the results of the multiple regression analysis were not significant because the variability within the SIT and SSI scores was small (individuals in the study had high SIT and SSI scores) although the data met the statistical assumptions required for regression analysis. Of note, the SIT approached significance in the initial multiple regression model (SIT and SSI only). It is possible that with a larger sample SIT would have proven significant for predicting change in CES. We also found that in our sample, the two speech intelligibility measures (SIT and SSI) were redundant in the multiple regression models. Further research will be done to determine which variable was the best predictor of change in CES.

In the post hoc analysis, using a multiple regression model that accounted for the two speech intelligibility measures (SIT and SSI), a measure of physical disability (H&Y), and dysarthria severity (DRS), the variable that accounted for the largest portion

of variability of observations in CES was the H&Y ( $p = .04$ ), a measure of physical disability, followed by the SSI (which approached significance at  $p = .10$ ). The results of this post hoc analysis gave us evidence that the CES was associated with a measure of participation (the H&Y) more than the measures of impairment (SIT or SIT).

We stated in the introduction that there is not a one-to-one relationship between speech intelligibility scores and successful functional communication (Weismer & Laures, 2002; Yorkston, 1996). Our results supported this literature. High SIT and SSI scores did not predict how an individual rated his communicative effectiveness in everyday speaking situations. Rather, based on our results, the rating of physical disability taken from the H&Y was the only significant predictor of change in CES ratings.

We recognized at the time of data analysis that our PD group was made up of individuals who had less physical impairment and dysarthria severity based on H&Y ratings and DRS ratings. We also recognized that the PD group had SIT and SSI scores that were relatively high ( $M = .94$  and  $M = .95$  respectively). In the future studies should be designed so that each level of severity is equally represented, and the numbers of participants in each group are large enough to ensure the power of our results are adequate to ensure the statistical rigor of our results.

The most important implication of the finding of Hypothesis 3 was that individuals with dysarthria and PD rated their communicative effectiveness less effective on everyday speaking situations although their speech intelligibility scores were high. We propose that this result demonstrated that the CES was tapping a different component of communication than the one tapped by either of the sentence intelligibility scores. We

suggest that this is evidence that the SIT and the SSI are measures of activity (as they have been presented to be) and the CES is a measure of communication in the societal participation component of the ICF. Some might argue that an individual with a speech intelligibility score of 95% should not be a candidate for speech therapy. However, if an individual was able to demonstrate decreased communicative effectiveness on the CES, that kept him from fulfilling his life roles in societal participation, he might well be a candidate for speech therapy. We are in the early stages of survey development trying to determine the validity and reliability of the CES; however another area that remains to be studied in the future is that of the sensitivity and specificity of the CES to identify those individuals whose communicative effectiveness is limiting their participation in fulfilling their life roles.

### **Limitations of the Study**

This study was not without limitations. The most obvious limitation, based on our post hoc analysis was that there are other factors that need to be taken into account besides an individual's speech when attempting to measure communicative effectiveness, such as physical ability. Additionally, we received input from both healthy community-dwelling individuals and community-dwelling individuals with PD and their SOs that other factors affected their judgments of how they spoke, including being ill-at-ease in speaking situations, being self-conscious about PD, being uncomfortable around strangers, being put on the spot, and having conversational partners who were hard of hearing, and/ or impatient.

Next, our SIT and SSI measures were redundant variables in the multiple regression models we devised. In the first multiple regression analysis model SIT

approached significance ( $p = .10$ ) and in the second (when severity was added into the model) the SSI approached significance ( $p = .10$ ).

In addition to the problem of redundancy, the literature presents conflicting reports on what role a spontaneous speech sample plays in determining speech intelligibility versus the traditional intelligibility measure where words and sentences are read by the speaker. Some authors report improved intelligibility because the listener can derive meaning from the context of what is being said (Dagenais, Garcia, & Watts, 1998; Dagenais, Watts, Turnage, & Kennedy, 1999; Hustad & Beukelman, 2002; Hustad & Beukelman, 2001; Hustad & Cahill, 2003). Others have found that spontaneous speech samples result in decreased intelligibility ratings (Kempler & Van Lancker, 2002). In our sample, the SIT and SSI tasks were redundant, which could lead one to suggest choosing just one speech intelligibility task. However, we also reviewed the transcription methodology we chose to determine if it would point to methodological problems we had overlooked.

A review of the inter-rater reliability on the SSI, although still good, was 10%-15% less than that of the SIT. Refer to Table 3-6. We used the AIDS transcription instructions for both intelligibility tasks (Yorkston et al., 1984). A key of correct sentences was available to check against the transcribed SIT samples. However, there were no keys with which to compare the SSI transcriptions. In the future, if a spontaneous speech sample is used, the PI could transcribe the SSI samples immediately after they are collected while the content of the sample was fresh. That transcription could serve as the key with which to compare the transcribed samples. This method

might reduce the amount of discrepancy between the intelligible words and unintelligible words in the SSI samples.

### **Improving the Communicative Effectiveness Survey**

Survey development typically involves getting input from individuals with the problem being studied and their significant others through focus groups or individual interviews. Such input gives ecological/social validity to a survey (Antonius et al., 1995; Lomas et al., 1989; Yorkston et al., 1994; Yorkston et al., 2001), which in turn should increase the likelihood of content validity and face validity of an instrument. Lomas and colleagues' (1989) designed the Communicative Effectiveness Index (CETI) to measure changes in the functional communication of individuals with aphasia. They used input from individuals with aphasia and caregivers during CETI development. Yorkston and colleagues (1999) modified the CETI to measure changes in the functional communication of individuals with motor speech disorders (such as the dysarthria associated with PD). As with the Lomas group, Yorkston and colleagues (1999) gathered input from individuals with a variety of motor speech disorders before modifying the CETI and called it the CES (the measure used in our study).

Because individuals with motor speech disorders had already given input into the survey, we did not use focus groups ahead of time but rather asked for feedback from the individuals with dysarthria and PD and their significant others after they had completed the CES. There were only a few addition items suggested. In the future, we will consider adding items to the instrument based on the input from the participants. Once items are added, further analysis would be made to ensure the stability of the measurement properties of the CES.

We believe the information participants gave in response to the third debriefing question “is there any other information about your communicative effectiveness that you think other healthcare professionals should know?” clearly showed that individuals with PD and their SO’s viewed communicative effectiveness as a societal participation measure. Examples of their responses included: feeling very self-conscious about one’s speech, having trouble communicating when being put on the spot, feeling tense made speech worse, being perceived as cognitively impaired because it is difficult to respond quickly. See Appendix C for a full listing of comments to all questions.

The groups’ responses also encompassed more than communication. Other things they thought healthcare professionals should know included: fear about what the future holds, disease progression, ability to remain independent, the strain the disease puts on marriage and family, personal safety, financial security, physical and emotional ups and downs, role reversals in relationships, stigma of PD (tremors, reduced mobility, using a wheelchair, slowness of thinking and responding), and impatience of the public.

Many of the concerns expressed had little to do with speech per se, but had much to do with maintenance of relationships and independence, both of which require certain levels of communicative effectiveness. Uncovering the impact that decreased communicative effectiveness has on those living with PD (both patient and significant others) is an area that is ripe for further research. This kind of research (qualitative research) is emerging in the aphasiology literature (Damico & Simmons-Mackie, 2003; Kagan & LeBlanc, 2002; Lyon, 2000), but there is very little of it being systematically done in the area of motor speech disorders in general, and hypokinetic dysarthria of Parkinson’s disease in particular (Antonius et al., 1995; Yorkston et al., 1994).

Future research questions that are of particular interest relative to doing qualitative research in the area of communicative effectiveness of individuals with dysarthria and PD include: 1) what does the phrase communicative effectiveness mean to you? 2) what are the biggest societal barriers you face to communicate effectively? 3) how do medication fluctuations affect your communicative effectiveness? 3) do you manage your medications to maximize communicative effectiveness in societal participation and if so, how? 4) do you manage your medications for other kinds of societal participation, and if so, how? Answers to these questions would be beneficial in further establishing the validity of communicative effectiveness as a measure of societal participation.

### **Conclusion**

In conclusion, this study has provided evidence that adds to the face validity, content validity, and construct validity of the CES as a measure of communication for the societal participation component the WHO ICF model. The CES differentiated healthy, community-dwelling elders from gender- and mean-age-matched individuals with dysarthria and PD. In addition, we showed that there was a significant difference between the way individuals with dysarthria and PD rated their communicative effectiveness and the way their significant others rated the communicative effectiveness of the individual with PD. Finally, we found evidence that individuals with dysarthria and PD rated their communication less effective, as their physical ability declined although their sentence intelligibility scores and spontaneous speech intelligibility scores remained high.

In motor speech disorders, we have many measures of body functions/structures (perceptual judgments, acoustic, and physiologic measures) and activity (speech intelligibility), but we have yet to develop a measure of communication in societal

participation. Such a measure is needed by speech therapists to demonstrate that the treatments they administer at the clinical level result in success for the client where the client needs it, to fulfill life roles at home, at work in the community. Such measures are also needed by researchers interested in motor speech disorders, so that as we go about designing studies to demonstrate the efficacy and effectiveness of new treatments we remember the goal of speech therapy is to enable a person to communicate more effectively to participate in his life roles.

Although there are many questions left to be answered regarding the reliability and other types of validity of the CES for individuals with dysarthria and PD, we believe we have presented evidence that the CES holds promise as a measure of communication for societal participation to fulfill life roles.

APPENDIX A  
COMMUNICATIVE EFFECTIVENESS SURVEY

NAME: \_\_\_\_\_

DATE: \_\_\_\_\_

In this survey we ask you to rate how effective **your speech** is in different communication situations. Please read each statement. Then rate how effectively you communicate in that situation. If you feel your speech is very effective, mark the 4. If your speech does not allow you to communicate at all in a situation, mark the 1. Feel free to use any number on the scale.

1. Having a conversation with a family member or friends at home.

Not able to do		Very Effective	
1	2	3	4

2. Participating in conversation with strangers in a quiet place.

Not able to do		Very Effective	
1	2	3	4

3. Conversing with a familiar person over the telephone.

Not able to do		Very Effective	
1	2	3	4

4. Conversing with a stranger over the telephone.

Not able to do		Very Effective	
1	2	3	4

5. Being part of a conversation in a noisy environment (social gathering).

Not able to do		Very Effective	
1	2	3	4

6. Speaking to a friend when you are emotionally upset or you are angry.

Not able to do		Very Effective	
1	2	3	4

7. Having a conversation while traveling in a car.

Not able to do		Very Effective	
1	2	3	4

8. Having a conversation with someone at a distance (across a room).

Not able to do		Very Effective	
1	2	3	4

Hustad, K.C., 1999. Optimizing Communicative Effectiveness: Bringing it together. In Yorkston, K.M., Beukelman, D.R., Strand, E.A., & Bell, K.R. (Eds.), *Management of Motor Speech Disorders* (2<sup>nd</sup> ed.), (pp.438-541).

APPENDIX B  
HOEHN AND YAHR STAGING FOR PARKINSON'S DISEASE

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

1. Stage One
  1. Signs and symptoms on one side only
  2. Symptoms mild
  3. Symptoms inconvenient but not disabling
  4. Usually present with tremor of one limb
  5. Friends have noticed changes in posture, locomotion and facial expression
  
2. Stage Two
  1. Symptoms are bilateral
  2. Minimal disability
  3. Posture and gait affected
  
3. Stage Three
  1. Significant slowing of body movements
  2. Early impairment of equilibrium on walking or standing
  3. Generalized dysfunction that is moderately severe
  
4. Stage Four
  1. Severe symptoms
  2. Can still walk to a limited extent
  3. Rigidity and bradykinesia
  4. No longer able to live alone
  5. Tremor may be less than earlier stages
  
5. Stage Five
  1. Cachectic stage
  2. Invalidism complete
  3. Cannot stand or walk
  4. Requires constant nursing care

Hoehn, M.M. & Yahr, M.D. (1967). Parkinsonism: onset, progression, and mortality. *Neurology*, 17(5): 427-442.

APPENDIX C  
PARTICIPANT FEEDBACK ON THE CES

Table C-1. Participant feedback

Question	Individuals with Dysarthria and PD	Significant Others
1. Overall, what is your impression of the survey?	<ul style="list-style-type: none"> <li>-Succinct, clear</li> <li>-Good and short</li> <li>-Short is a good thing</li> <li>-I like short tests</li> <li>-Short &amp; sweet</li> <li>-You need more numbers. I would have liked to put some in-between</li> <li>-Simple and understandable</li> <li>-Is this enough questions to be meaningful?</li> <li>-I am neutral on it</li> <li>-It was quick and easy</li> <li>-I'm benign on it</li> <li>-Good and short</li> <li>-I may be a 3.5 on some</li> </ul>	<ul style="list-style-type: none"> <li>-Some of the wording is not clear</li> <li>-It doesn't really apply to most of our problems with lifestyle changes</li> <li>-Very lifelike and applicable</li> </ul>
2. Are there other social speaking situations we should add to this survey?	<ul style="list-style-type: none"> <li>-Perhaps a question about conversing for a lengthy period of time</li> <li>-I don't see anything about my speech when I am tired</li> <li>-Outdoors is a problem, I can't yell like I used to</li> <li>-Hard to order food at a restaurant with the noise and the rush</li> <li>-Maybe something about talking faster-that is my wife's complaint</li> <li>-Most of my friends are hard of hearing. I think that is the problem.</li> <li>-I don't answer the phone anymore so that question doesn't really apply to me.</li> <li>-Add something about fatigue level and speaking.</li> <li>-You need a question about talking when you are in an anxious situation, or being judged, not just mad or whatever.</li> <li>-Change the emotionally upset question. I don't let myself get mad. Maybe use the term emotionally involved.</li> <li>-It is hard to talk and dance and we love to dance.</li> </ul>	<ul style="list-style-type: none"> <li>-I worry when he is outdoors by himself he can't yell at me for help.</li> <li>-Maybe ask about talking at home with the TV on or when there are other people here—it makes a difference.</li> <li>-When all the grandchildren are here I can't hear him. Maybe one about talking when he is tired.</li> <li>-When more than two of us are here at home it is hard to hear him and he cannot seem to get into the conversation—it is as though we pass him by.</li> </ul>

Table C-1 continued.

Question	Individuals with Dysarthria and PD	Significant Others
3. Is there any other information about your communicative effectiveness that you think other healthcare professionals should know?	<p>-I notice my voice is quieter, but I don't think it makes much difference, does it?</p> <p>-I am newly diagnosed but worry about the future and what is going to happen.</p> <p>-Nobody realizes how much I fluctuate from day to day, not because of meds, but just how I feel in general</p> <p>-I have trouble speaking when I am put on the spot for an answer</p> <p>-People seem to think I am more cognitively impaired because of my slowness to respond</p> <p>- Everyone notices how clear my speech is when I am mad</p> <p>-Everything is harder now</p> <p>-Exercise helps my fatigue</p> <p>-My voice is worse when I get confused, like when I am tired.</p> <p>-I want everyone to know that therapy helps. I think people interact differently with me because I come across as a competent communicator now and I speak up.</p> <p>-Feeling tense makes my speech worse</p> <p>-The hearing of the listener is very important</p> <p>-I have become very self-conscious about my speech</p> <p>-My husband won't go and leave me alone although I want him to because I can take care of myself very well.</p> <p>-I don't want to be a burden to my wife, but I already am</p> <p>-It is hard on the person I am with. I have lost my facial expression and he can't tell when I am happy.</p> <p>-Everything takes a long time to do and people aren't always patient.</p>	<p>-No one really addresses caregiver burden. I am trapped here with him.</p> <p>-He knows everyone around here and is embarrassed by some of his problems. No one has talked to us about that kind of thing.</p> <p>-PD is very hard on a marriage and nobody tells you that.</p> <p>-The fear of what is coming is almost unbearable.</p> <p>-I feel desperate.</p> <p>-I take Prozac to manage my feelings of dread for what is ahead.</p> <p>-We are both getting older and our kids are up north. We don't have much help.</p> <p>-I have to do all kinds of things I never thought I would do.</p> <p>-I don't like making decisions by myself, but sometimes I just do.</p> <p>-It takes us so long to do anything that it is easier to stay home.</p>

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