Journal of Communication Disorders 56 (2015) 103–112

Contents lists available at ScienceDirect

Journal of Communication Disorders

Examining the relationship between speech intensity and self-rated communicative effectiveness in individuals with Parkinson's disease and hypophonia

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ARTICLE INFO

Article history:
Received 21 January 2015
Received in revised form 10 June 2015
Accepted 22 June 2015
Available online 6 July 2015

Keywords:
Parkinson's disease
Communicative effectiveness
Speech intensity
Hypophonia
Speaker-listener dyads

ABSTRACT

Purpose: To examine the relationship between speech intensity and self-ratings of communicative effectiveness in speakers with Parkinson's disease (PD) and hypophonia. An additional purpose was to evaluate if self-ratings of communicative effectiveness made by participants with PD differed from ratings made by primary communication partners.
Methods: Thirty participants with PD and 15 healthy older adults completed the Communication Effectiveness Survey. Thirty primary communication partners rated the communicative effectiveness of his/her partner with PD. Speech intensity was calculated for participants with PD and control participants based on conversational utterances.
Results: Results revealed significant differences between groups in conversational speech intensity ($p = .001$). Participants with PD self-rated communicative effectiveness significantly lower than control participants ($p = .000$). Correlational analyses revealed a small but non-significant relationship between speech intensity and communicative effectiveness for participants with PD ($r = 0.298$, $p = .110$) and control participants ($r = 0.327$, $p = .234$). Self-ratings of communicative effectiveness made participants with PD was not significantly different than ratings made by primary communication partners ($p = .20$).
Conclusions: Obtaining information on communicative effectiveness may help to broaden outcome measurement and may aid in the provision of educational strategies. Findings also suggest that communicative effectiveness may be a separate and a distinct construct that cannot necessarily be predicted from the severity of hypophonia.

1. Introduction

Speech and voice abnormalities are a common and often disabling consequence of Parkinson's disease (PD). It is estimated that over 75% of individuals diagnosed with Parkinson's disease will present with speech and voice abnormalities related directly to PD (Logemann, Fisher, Boshes, & Blonsky, 1978; Sapir et al., 2002). Hypophonia, or reduced speech intensity, can be a consequence of hypokinetic dysarthria associated with PD. Hypophonia often emerges as an initial speech

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http://dx.doi.org/10.1016/j.jcomdis.2015.06.012
0021-9924/

symptom in the beginning stages of PD (Logemann et al., 1978). Ludlow and Bassich, and Gamboa and colleagues found that hypophonia was present in 42% and 49% of individuals they studied with hypokinetic dysarthria, respectively (Gamboa et al., 1997; Ludlow & Bassich, 1984). Fox and Ramig (1997) suggest that on average individuals with PD have intensity levels 2–4 dB SPL lower than age-matched control participants. More recently, Dykstra and her colleagues reported habitual conversational intensity values for individuals with PD to be approximately 5 dB SPL less intense than control participants, and approximately 5 dB SPL less intense than control participants in various intensity levels of background noise (Dykstra, Adams, & Jog, 2012).

Given this growing body of evidence that acknowledges many individuals with PD can have significant hypophonia and can have difficulty regulating speech intensity, it is conceivable that individuals with hypophonia may have significant difficulty communicating and participating effectively in a variety of speaking situations. These speaking situations could include speaking while traveling in car, speaking while in a busy restaurant, or at a social gathering. Therefore, it is important to broadly assess hypophonia from a perspective that addresses the impact of the speech disorder on successful communicative interactions. One way of achieving this is to assess an individual's perception of his/her ability to participate and communicate effectively in different speaking situations and to also assess how communicative partners perceive the communicative effectiveness of their partner with PD. This information has the potential to inform treatment planning and to augment the quality of healthcare individuals with PD and hypophonia receive.

There is an emerging body of empirical literature based on the construct of "communicative participation" (see Baylor, Burns, Eadie, Britton, & Yorkston, 2011; Baylor et al., 2013). Communicative participation has its roots within the conceptual framework of the World Health Organization's International Classification of Functioning, Disability and Health (ICF) (WHO, 2001). According to the ICF, the health domain/construct "body functions and body structures" describes aspects of an impairment related to body systems and body structures (WHO, 2001, p. 8). Within the context of the ICF, "participation" is a construct that refers to the nature and the extent of an individual's involvement in life situations (WHO, 2001). Restrictions in participation represent the difficulties individuals can experience in life situations due to the circumstances of their health condition (WHO, 2001). Within the realm of communication, participation refers to the roles and activities that one chooses which involve communication within the context of daily life (WHO, 2001). Eadie and her colleagues suggested a definition of communicative participation as "Taking part in life situations where knowledge, information, ideas or feelings are exchanged. This may take the form of speaking, listening, reading, writing, or nonverbal means of communication" (p. 309) (Eadie et al., 2006). Included within the construct of participation is "communicative effectiveness". Communicative effectiveness was defined by Hustad (1999) as a person's ability to communicate successfully messages in home and community settings to fulfill life roles.

Understanding the participation dimension of functioning allows one to examine how an individual participates in social contexts. Measures of communication effectiveness such as the Communicative Effectiveness Survey (CES) (Donovan, Kendall, Young, & Rosenbek, 2008; Donovan, Velozo, & Rosenbek, 2007; Donovan, Velozo, Rosenbek, Okun, & Sapienza, 2005; Hustad, 1999) can be used to obtain information about the effectiveness of communicative participation in individuals with dysarthria. Other instruments such as the Voice Activity and Participation Profile (VAPP) (Ma & Yiu, 2001), the Voice Handicap Index (VHI) (Jacobson et al., 1997), the Dysarthria Impact Profile (Walshe, Peach, & Miller, 2008), and most recently, the Communicative Participation Item Bank (Baylor et al., 2013) are tools that have been used to examine communicative participation in a variety of communication disorders, including dysarthria (for a thorough review of these instruments, the reader is directed to Eadie et al., 2006). Unfortunately, the relationship between acoustic measures of hypophonia (i.e., speech intensity) and the impact on participation is poorly understood. The majority of research in motor speech disorders has focused on understanding the physiological and perceptual underpinnings of dysarthria. Fewer studies have attempted to delineate the relationship between acoustic measures such as speech intensity (ICF "body functions and structures") and subjective, patient-reported outcome measures such as communicative effectiveness (i.e., ICF "participation"). A review of the extant literature reveals that the relationship between ICF impairment based measures (i.e., speech intensity) and participation has not been explored in individuals with PD. Therefore, obtaining patient reported outcomes on communicative participation in addition to clinically based outcome measures, such as speech intensity is desirable because it can ensure contextually relevant communicative rehabilitation for individuals with dysarthria and it can ensure a breadth of outcome measurement.

In addition to obtaining patient reported outcomes of communicative participation, it is of interest to investigate proxy ratings of communicative participation. Obtaining information on communicative participation from the perspective of the individual with PD and from the perspective of his/her communication partner is important information to gather in order to determine if differences in perceptions exist. This information can be of value clinically in the provision of strategies to overcome communication breakdown between partners. The agreement between patient and proxy reports has been studied among individuals with PD with varying results (Fleming, Cook, Nelson, & Lai, 2005; Martinez-Martin et al., 2004; McRae, Diem, Vo, O'Brien, & Seeberger, 2002). For example, McRae et al. (2002) found a high level of agreement between individuals with PD and their caregivers on responses to the Schwab and England Activities of Daily Living scale, and Hoehn and Yahr staging. Martinez-Martin et al. (2004) evaluated quality of life (QoL) in PD-proxy dyads. The study by Martinez-Martin and colleagues also found concordance in dyad responses, but the responses that pertained to more objective variables had higher concordance than more subjective variables. In their evaluation of QoL and physical activity in PD-proxy dyads, Fleming and her colleagues found that, in general, proxies rated patient disability higher and rated QoL lower than did the individuals with PD (Fleming et al., 2005). In contrast to the study by Martinez-Martin, Fleming's study found there was greater agreement between individuals with PD and their proxies on the QoL scale, a subjective measure, than the more objective, physical activity scale. This is an interesting finding since the patient-proxy literature suggests that objective variables tend to have greater patient-proxy agreement than more subjective variables (Andresen, Vahle, & Lollar, 2001; Lobchuk & Degner, 2002).

The purpose of the present study is to study the relationship between speech intensity and self-ratings of communicative effectiveness made by individuals with PD and hypophonia. An additional purpose is to evaluate if self-ratings of communicative effectiveness made by participants with PD differ from ratings made by primary communication partners.

2. Methods

2.1. Participants

Thirty participants (21 males, 9 females) with hypophonia as a result of mild to severe idiopathic PD (Hoehn & Yahr stages 1–4) (age range: 43–77 years, mean age = 63.26 years) with an average PD onset of 8.6 years (range: 2–26 years) and 15 healthy control participants (6 males, 9 females, age range: 43–78 years, mean age = 65.6 years) participated in this study. Participants with PD were reported by two Speech-Language pathologists and a Neurologist specializing in movement disorders to demonstrate hypokinetic dysarthria. Specifically, participants with PD were judged to demonstrate hypophonia. The presence of hypophonia was the primary inclusion criterion of this study. Additional inclusion criteria included: (1) all control participants and all participants with PD were required to have no prior history of speech, language, or hearing problems (except those related to PD); (2) all participants with PD were required to pass a cognitive screening using the Mini Mental State Examination (MMSE) with a cut-off score of 23 (Folstein, Folstein, & McHugh, 1975); and (3) all participants (control, PD, primary communication partners) were required to pass a 30 dB HL hearing screening at 500, 1000, 2000 and 4000 Hz in both ears. All participants with PD were stable on their anti-parkinsonian medication and were tested, in an ‘‘on’’ state, at approximately 1 h after taking their regularly scheduled anti-parkinsonian medication. Thirty primary communication partners ($n = 30$) also participated in this study. Communication partners were required to have daily or frequent contact with the participant with PD. Primary communication partners were defined as spouses, children, best friends, and/or caregivers of participant's with PD. Table 1 provides a description of the demographic information for the participants with PD and his/her primary communication partner. Sentence intelligibility scores are included in Table 1 to demonstrate that speech intelligibility was relatively unimpaired for 27/30 participants with PD. Two naïve listeners rated speech intelligibility in sentences using the standard protocol and scoring procedures outlined in the Sentence Intelligibility Test (Yorkston, Beukelman, & Tice, 2011). Speech intelligibility was evaluated in order to demonstrate that intelligibility was not impaired for the majority of the participants with PD. Based on psychometric evaluation, the SIT has been found to be reliable and valid measure of speech intelligibility for dysarthric speakers (Yorkston et al., 2011). Table 2 provides a description of the control participants. All participants provided informed consent prior to participation in this study which was approved by the Health Sciences Research Ethics Board at Western University.

2.2. Procedures

2.2.1. Habitual conversational speech intensity

Control participants and participants with PD were tested in an audiometric booth (Industrial Acoustic Company). Participants wore a headset microphone (AKG-c420) positioned at a constant 6 cm distance from the mouth. The experimenter sat 150 cm in front of the participant. The headset microphone's audio signal was recorded using a dual-channel digital audio recorder (Tascam DA-01) that digitized the audio signals at 44.1 kHz and 16 bits. The recorded signals were digitally transferred from the digital tape to a computer using the DAT interface of the Computerized Speech Lab (Model 4300B, Kay Elemetrics) and the CSL software. Calibration of the headset microphone recording was established through the use of a sound level meter that was placed 15 cm (6 inch) from the participant's mouth while the participant produced 1–2 s of a prolonged ‘‘ah’’ at 70 dBA SPL as indicated on the sound level meter. Once this 70 dBA SPL reference signal was digitally transferred to the computer, a conversion factor was obtained and applied to all of the computer-based intensity measures. Thus, in the present study, the participants' headset microphone recordings were converted to a reference SPL value obtained at 15 cm from the mouth. This method of converting headset microphone signals into calibrated SPL units has been described by Winholtz and Titze (1997). In the present study we modified the original conversion method by using stable prolonged vowel signals (70 dBA SPL) from the participant instead of artificially generated sounds. A similar modification of the original conversion method has been used in several other studies (Clark, Adams, Dykstra, Moodie, & Jog, 2014; Svec, Popolo, & Titze, 2003). The reader is referred to the Appendix which provides a more detailed description of the calibration procedure.

The experimenter engaged participants in approximately 2 min of conversation. For the 2-min segment of conversation, six utterances of approximately 7–10 s each were extracted and analyzed separately and the mean intensity was calculated. This criterion was used to capture longer utterances that did not contain pauses, hesitations, or extraneous noise (e.g., throat clearing, coughs). Each 7–10 s of utterances was analyzed separately using the Visipitch module associated with the CSL program (Model 4300B). The utterances were displayed on a computer screen and isolated with user-controlled cursors. Once isolated, the Visipitch program calculated a calibrated average intensity of the utterance in dB SPL.

Table 1
Description of participants with PD and his/her primary communication partner (PCP).

PD	Age	Sex	PD duration (years)	Anti-PD medications	Habitual conversational speech intensity (dB A SPL @ 15 cm)	Sentence intelligibility (%)	Living situation	PCP
1	55	M	6	Amantadine	67.88	91.8	With spouse	Spouse
2	54	F	10	Mirapex, Sinemet	62.95	95.85	With spouse	Spouse
3	66	M	5	Sinemet, Permex	68.92	98.6	With spouse	Spouse
4	66	M	8	Sinemet	64.82	99.05	With spouse	Spouse
5	55	M	6	Simemet, Permax	69.75	94.5	With spouse	Spouse
6	55	M	8	Sinemet, Permax	72.89	98.15	With spouse	Spouse
7	67	M	12	Sinemet, Mirapex	67.05	97.7	With spouse	Spouse
8	66	F	2	Sinemet, Propranalol	72.10	99.05	With spouse	Spouse
9	64	F	6	Sinemet, Permax, Mirapex	69.66	90.9	With spouse	Spouse
10	72	M	17	Sinemet	64.53	69.9	With spouse	Spouse
11	75	M	8	Sinemet	72.43	98.15	With spouse	Spouse
12	68	M	3	Sinemet	65.77	98.15	With spouse	Spouse
13	64	F	15	Sinemet	65.38	100	With spouse	Spouse
14	55	M	10	Sinemet	64.81	98.15	With spouse	Spouse
15	55	M	3	Sinemet, Requip	66.62	98.6	With spouse	Spouse
16	61	M	5	Amantadine, Mirapex	67.99	96.2	With spouse	Spouse
17	63	F	6	Sinemet	72.31	98.6	With spouse	Spouse
18	53	M	6	Sinemet, Requip	66.69	99.5	With spouse and child	Spouse
19	60	F	10	Sinemet	70.76	100	With spouse	Spouse
20	68	M	10	Sinemet, Requip	61.54	93.15	With spouse	Spouse
21	77	M	5	Sinemet	63.82	100	With spouse	Spouse
22	61	F	11	Sinemet. Permax	68.11	95.9	Alone, independently	Friend
23	74	M	7	Sinemet	60.87	94.5	With spouse	Friend
24	70	F	11	Sinemet	61.07	92.25	With spouse	Spouse
25	63	M	6	Lamectal, Propranalol	68.27	98.6	With spouse	Spouse
26	43	M	2	Sinemet, Mirapex	68.45	99.05	With spouse and two children	Spouse
27	61	M	10	Sinemet	67.83	95.4	Alone, independently	Friend
28	69	M	26	Sinemet, Domperidone, Propranalol	65.96	15.4	With spouse	Spouse
29	66	M	18	Sinemet, Amantadine, Requip	65.95	98.15	Alone, independently	Friend
30	72	F	6	Sinemet	60.51	53.15	With spouse	Spouse

Approximately 5% or 15 conversational utterances were re-measured by the examiner to evaluate the intra-judge reliability for ratings of speech intensity. A second person also measured approximately 5% or 15 conversational utterances for speech intensity ratings in order to determine the inter-judge reliability. The Pearson correlation coefficients obtained for intra-judge and inter-judge reliability was .996 and .992, respectively ($p = .001$). These correlation coefficients demonstrate a very high reliability within and between judges for intensity measures.

Table 2
Description of healthy control participants.

Control	Age	Sex	Habitual conversational speech intensity (dB A SPL @ 15 cm)
1	78	F	72.64
2	66	F	70.51
3	73	F	73.22
4	69	M	69.98
5	65	F	70.88
6	61	F	73.90
7	59	M	73.68
8	70	F	73.34
9	75	F	67.33
10	73	M	73.55
11	64	F	70.89
12	63	M	75.29
13	67	F	66.76
14	58	M	70.88
15	42	M	74.39

2.2.2. Communicative effectiveness

Communicative effectiveness was assessed using the Communicative Effectiveness Survey (CES) (Hustad, 1999). The construct validity of the CES has been evaluated in individuals with dysarthria secondary to PD (Donovan et al., 2008). The CES was administered to each control participant, participant with PD, and to his/her primary communication partner. The CES is a 10-item questionnaire focusing on social communication on a 7-point Likert scale. A score of 1 equals "not at all effective" and 7 equals "very effective". Means of the sums for each individual question was used to designate the ratings of communicative effectiveness for that context. This scoring procedure has been used in previous studies (see Ball, Beukelman, & Pattee, 2004; McAuliffe, Carpenter, & Moran, 2010). Participants with PD and control participants self-rated how effectively they communicate in a variety of social situations. Primary communication partners rated how effectively they perceived his/her partner with PD to communicate in the same social situations. Verbal instructions were given to the participants prior to completion of the survey. Each control participant, participant with PD and his/her primary communication partner completed the CES independently, but during the same single experimental visit to avoid response interference.

3. Results

3.1. Habitual conversational speech intensity

This analysis served to provide confirmation that our participants with PD were hypophonic. An independent samples *t*-test evaluated habitual conversational speech intensity between participants with PD and control participants. This analysis revealed a significant difference in habitual conversational intensity between groups (t (43) = 4.909; p = .001). More specifically, the mean habitual conversational speech intensity levels for the control group was 71.82 dB SPL (SD = 2.51) and the PD group was 66.86 dB SPL (SD = 3.48). This result suggests that participants with PD showed habitual conversational intensity levels that were significantly less intense (by −5 dB SPL) than those of control participants.

3.2. PD versus control participants' ratings of communicative effectiveness

This analysis sought to provide evidence that our participants with PD experienced a reduction of self-perceived communicative effectiveness compared to control participants. A one-factor multivariate analysis of variance, in which the items of the CES served as dependent variables was used to evaluate any differences between groups. The multivariate analysis demonstrated a statistically significant effect of the CES variables, $F(10,34) = 9.30$, $p = .000$, $\eta^2 = 0.732$. The univariate analysis examined in closer detail a hierarchy of CES items based on effect size. Based on this analysis, all of the univariate comparisons demonstrated a statistically significant effect for the group difference – and all of the differences were in the same direction (i.e., scores for individuals with PD were significantly lower than the control participants). These results are presented in Table 3. This result demonstrates that our participants with PD rated themselves has having reduced communicative effectiveness relative to control participants.

3.3. Relationship between PD habitual conversational speech intensity and ratings of perceived communicative effectiveness

The primary purpose of this study was to examine the relationship between speech intensity and communicative effectiveness in participants with PD and hypophonia. The mean score of the 10 items on the CES was calculated for each

Table 3
Descriptive statistics and results of the univariate analyses of differences between participants with PD and control participants, ranked in order of largest effect to smallest effect.

CES item	PD *Mean (SD)*	Control *Mean (SD)*	Univariate analyses
Q.7 Having a conversation with someone at a distance	2.80 (1.06)	5.40 (0.83)	$F(1,43) = 68.557$, $p = .000$, $\eta_p^2 = 0.615$
Q.6 Having a conversation while traveling in a car	3.73 (1.23)	6.40 (0.74)	$F(1,43) = 59.413$, $p = .000$, $\eta_p^2 = 0.580$
Q.10 Having a long conversation with someone (over an hour)	3.40 (1.48)	6.00 (1.00)	$F(1,43) = 37.653$, $p = .000$, $\eta_p^2 = 0.467$
Q.9 Speaking or having a conversation before a group	3.27 (1.26)	5.73 (1.33)	$F(1,43) = 36.954$, $p = .000$, $\eta_p^2 = 0.462$
Q.8 Having a conversation with someone in a noisy environment	2.93 (1.11)	4.93 (1.03)	$F(1,43) = 33.858$, $p = .000$, $\eta_p^2 = 0.441$
Q.5 Having a conversation with a stranger over the phone	3.83(1.34)	5.87 (1.13)	$F(1,43) = 25.434$, $p = .000$, $\eta^2{}_p = 0.372$
Q.1 Having a conversation with familiar persons in a quiet environment	5.07 (1.20)	6.66 (0.49)	$F(1,43) = 24.354$, $p = .000$, $\eta_p^2 = 0.362$
Q.3 Having a conversation with a familiar person over the phone	4.80 (1.40)	6.60 (0.63)	$F(1,43) = 22.327$, $p = .000$, $\eta_p^2 = 0.342$
Q.4 Having a conversation with young children	4.33 (0.99)	5.73 (1.16)	$F(1,43) = 17.706$, $p = .000$, $\eta_p^2 = 0.292$
Q.2 Having a conversation with strangers in a quiet environment	4.40 (1.35)	5.87 (1.12)	$F(1,43) = 13.040$, $p = .001$, $\eta_p^2 = 0.233$

participant with PD and was compared to his/her habitual conversational speech intensity. Correlational analyses employed a Pearson product moment correlation. Results revealed a small, but non-significant relationship between habitual conversational speech intensity and average self-ratings of communicative effectiveness ($r = 0.298$, $p = .110$) for participants with PD. Similarly, there was small, but non-significant relationship between habitual conversational speech intensity and self-ratings of communicative effectiveness ($r = 0.327$, $p = .234$) for the healthy control participants.

3.4. Agreement of ratings on CES items: participants with PD and primary communication partners

The secondary purpose of this study was to evaluate if participants with PD and their primary communication partners provided similar ratings of communicative effectiveness. A one-factor multivariate repeated measures analysis of variance, in which the items of the CES were compared between two matched groups (individuals with PD and their primary communication partner) was completed. The multivariate analysis demonstrated no statistically significant difference between groups, $F(10,20) = 1.526$, $p = .20$, $\eta^2 = 0.433$. Furthermore, none of the univariate analyses demonstrated statistically significant differences between groups. These univariate analyses are presented in Table 4. As should be apparent in this table, the magnitude of the differences between the ratings provided by individuals with PD and their primary communication partners was (for all variables) quite small, with effect sizes (as measured by a partial η^2) ranging from 0.00 to 0.069. This suggests that the lack of statistically significant effects is more likely to be the result of a true absence of effect, rather than a lack of power.

4. Discussion

The primary purpose of this study was to determine if a relationship existed between speech intensity and self-ratings of communicative effectiveness in individuals with PD and hypophonia. A secondary purpose was to explore how primary communication partners perceived and rated the communicative effectiveness of his/her partner with PD in order to determine if there were similarities or differences in ratings between groups.

The overarching objective of this study was to examine hypophonia in Parkinson's disease from a broader perspective. The World Health Organization's International Classification of Functioning, Disability and Health (ICF) (WHO, 2001) served loosely as the conceptual framework for examining hypophonia in PD from a multidimensional approach. This perspective was taken to examine potential linkages between levels of disability [i.e., impairment (speech intensity) and participation restriction (communicative effectiveness) domains] experienced by our participants with PD and hypophonia.

4.1. Habitual conversational speech intensity

Habitual conversational speech intensity was found to be approximately 5 dB SPL less (PD: 66.86 dB SPL, $SD = 3.48$ versus Control: 71.82 dB SPL, $SD = 2.51$) than control participants. This value is comparable to that of Fox and Ramig (1997) who found that on average, individuals with PD have speech intensity levels 2–4 dB SPL lower than age-matched, control participants. Overall, this finding provides confirmatory evidence that our speakers had hypophonia.

4.2. PD versus control participants' ratings of communicative effectiveness

There were significant differences between participants with PD and control participants on every item on the CES. The magnitude of difference between groups suggests that individuals with PD and hypophonia self-report significant

Table 4
Descriptive statistics and results of the univariate analyses of differences between PD and PCP.

CES item	PD *Mean* (*SD*)	PCP *Mean* (*SD*)	Univariate analyses
Q.1 Having a conversation with familiar persons in a quiet environment	5.07 (1.20)	4.97 (1.61)	$F(1,29) = 0.103$, $p = .751$, $\eta^2_p = 0.004$
Q.2 Having a conversation with strangers in a quiet environment	4.40 (1.35)	4.60 (1.59)	$F(1,29) = 0.326$, $p = .573$, $\eta^2_p = 0.011$
Q.3 Having a conversation with a familiar person over the phone	4.80 (1.40)	4.53 (1.72)	$F(1,29) = 0.738$, $p = .397$, $\eta^2_p = 0.025$
Q.4 Having a conversation with young children	4.38 (.99)	4.70 (1.62)	$F(1,29) = 1.52$, $p = .228$, $\eta^2_p = .050$
Q.5 Having a conversation with a stranger over the phone	3.83(1.34)	4.30 (1.68)	$F(1,29) = 2.17$, $p = .152$, $\eta^2_p = 0.070$
Q.6 Having a conversation while traveling in a car	3.73 (1.23)	3.73 (1.64)	$F(1,29) = 0.000$, $p = 1.00$, $\eta^2_p = 0.000$
Q.7 Having a conversation with someone at a distance	2.80 (1.06)	3.30 (1.66)	$F(1,29) = 2.14$, $p = .154$, $\eta^2_p = 0.069$
Q.8 Having a conversation with someone in a noisy environment	2.93 (1.11)	3.23 (1.70)	$F(1,29) = 0.765$, $p = .389$, $\eta^2_p = 0.026$
Q.9 Speaking or having a conversation before a group	3.27 (1.26)	3.57 (1.63)	$F(1,29) = 0.929$, $p = .343$, $\eta^2_p = 0.031$
Q.10 Having a long conversation with someone (over an hour)	3.40 (1.48)	3.80 (1.61)	$F(1,29) = 1.17$, $p = .289$, $\eta^2_p = 0.039$

reductions in communicative effectiveness relative to control participants. This result supports the findings of Donovan et al. (2008) who also demonstrated that mean CES ratings for the PD group were significantly lower than the non-PD group. Upon closer examination of Table 3, the items on the CES with the largest effect size: ''Having a conversation with someone at a distance'' and ''Having a conversation while traveling in a car'' accounted for approximately 61.5% and 58% of the variance between participants with PD and control participants on each item, respectively. Since our participants with PD presented with hypophonia, it is of interest that the CES items related to speaking in acoustically challenging contexts such as while conversing over increased interlocutor distances, and while traveling in a car, had the greatest effect sizes. This suggests that there may be a specific hierarchy or profile of communicative situations that individuals with PD and hypophonia find more communicatively challenging. This result may be capturing the consequences of hypophonia which may be expressed as difficulty with vocal projection over distances, and in noise such as traveling in a car. This information could provide potentially important information for assessment, treatment planning, and provision of educational strategies to deal with communication breakdown for individuals with hypokinetic dysarthria.

4.3. Relationship between speech intensity and self-ratings of communicative effectiveness

The primary purpose of this study was to explore the relationship between speech intensity and communicative effectiveness in participants with PD and hypophonia. Our results revealed a small, but a non-significant relationship between speech intensity (an ICF impairment level domain) and communicative effectiveness (an ICF participation level domain). This result suggests a weak relationship between speech intensity and perceived communicative effectiveness. Since this study represents the first of its kind to examine the relationship between communicative effectiveness and speech intensity, this finding will require additional exploration in a larger scale study. The relationship between ICF activity and participation has been investigated in studies examining the association between speech intelligibility and communicative effectiveness in ALS (Ball et al., 2004), traumatic brain injury (TBI) (McAuliffe et al., 2010) and PD (Donovan et al., 2008) with differing results. For example, Ball and colleagues found that in speakers with ALS, there was a significant positive relationship between sentence intelligibility and self-ratings of communicative effectiveness ($r = 0.945$, $p = .000$) (Ball et al., 2004). On the contrary, McAuliffe and colleagues, and Donovan and others did not find significant relationships between speech intelligibility and self-ratings of communicative effectiveness in participants with TBI ($r = 0.02$, $p = .92$) and PD (SIT scores accounted for 12% of the observed variance), respectively (Donovan et al., 2008; McAuliffe et al., 2010). Taken together, an interpretation of these results may suggest that there is not simple one-to-one relationship between the severity of the communication disorder, as measured by acoustic or perceptual clinical outcome measures, and communicative participation (Brady, Clark, Dickson, Paton, & Barbour, 2011; Donovan et al., 2008; Yorkston, Klasner, & Swanson, 2001). For example, Yorkston et al. (2001) demonstrated that mild speech impairments resulted in significant restrictions in communicative opportunities in dysarthric individuals with multiple sclerosis. The study by Yorkston and her colleagues demonstrates the necessity of understanding the consequences of one's communication disorder as it relates to communication at a personal level. It also suggests that restrictions in participation may not be able to be predicted from the severity of the speech disorder. Yorkston also stated that participation (e.g., communicative effectiveness) is a separate and a distinct construct from other domains of functioning such body functions and structures (e.g., speech intensity) and activity (e.g., speech intelligibility). Therefore, one cannot assume that performance or limitations in one area will be predictive of the other.

4.4. Differences in perceptions of overall communicative effectiveness: PD and primary communication partners

In the current study, no significant differences were identified on ratings made by our participants with PD and those made by their primary communication partners. This finding suggests significant agreement between groups on ratings of communicative effectiveness. Our findings are consistent with the results of Fleming et al. (2005) in that there was substantial agreement between PD and primary communication partners' ratings of communicative effectiveness, which are subjective questions. Our results also are similar to studies by McAuliffe and colleagues and Ball and others who examined perceptions of communicative effectiveness by patient-proxy dyads in individuals with traumatic brain injury (TBI) and ALS, respectively (Ball et al., 2004; McAuliffe et al., 2010). Similar to the McAuliffe and Ball studies, the present study found no significant difference between self-ratings of communicative effectiveness between the participants with PD and their primary communication partners (Ball et al., 2004; McAuliffe et al., 2010). Interestingly, our results are in contrast to Donovan et al. (2008) who found a statistically significant difference between CES ratings made by individuals with PD and their significant others. Specifically, Donovan found that individuals with PD self-rated communicative effectiveness higher as compared to their significant others (Donovan et al., 2008). Donovan and colleagues partly attributed this result to lack of insight by individuals with PD. Although self-report is the preferred method of gathering information on communicative effectiveness, or any type of subjective information, it is promising that a primary communication partner may be able to provide a similar appraisal should the patient be unable to.

Donovan and colleagues suggested that the advantage of having ratings of communicative effectiveness made by both the patient and his/her primary communication partner is that this information may provide clinicians with an opportunity to establish treatment goals that are mutually agreed upon by both parties and to begin providing information and training to the communicative dyad early on (Donovan et al., 2008). Ball and colleagues suggested that obtaining information on communicative effectiveness from both the speaker and his/her communication partner is important information to gather, especially if differences in perceptions are found to exist. If differences were found to exist, potential goals of intervention could be addressing disagreements, and agreeing on effective communication goals and solutions (Ball et al., 2004). This information may be beneficial for treatment planning and the provision of educational strategies that focus on improving speaker–listener communicative interactions.

5. Limitations and future directions

The current study represents preliminary work examining the construct of communicative participation in PD. The findings of this study should be interpreted with caution due to some study limitations. These limitations relate to a relatively small sample size and the absence of depression ratings which may have impacted the results. The relationship between impairment (e.g., speech intensity) and participation (e.g., communicative effectiveness) domains is complex, and this relationship is likely dependent upon a variety of factors that are unique to the individual and to his/her environment (McAuliffe et al., 2010). The delineation of these potentially nonlinear variables is worthy of careful consideration in a future study. Future studies may also seek to examine the relationship between conversational intelligibility and communicative effectiveness, and the effect of speaking in background noise on self-ratings of communicative effectiveness. Finally, it may be of interest in a future study to stratify participants based on severity when examining specific profiles of communicative effectiveness, and patient-proxy dyad ratings.

6. Conclusions and implications

The current study adds to a growing body of literature that suggests communicative participation may be a separate and a distinct construct from other outcome measures. In other words, one's perception of communicative effectiveness (communicative participation) may not necessarily be predicted from the severity of the communication disorder (Donovan et al., 2008; McAuliffe et al., 2010; Yorkston et al., 2001), such as hypophonia. In general, the implications of these findings suggest the importance of gathering information on communicative effectiveness from individuals with PD and hypophonia. This information has the potential to provide insight into self-perceptions of communicative effectiveness, and the degree of difficulty an individual may experience in different social situations despite the severity of hypophonia. This information can help inform the clinician of the situational difficulty individuals with dysarthria can endure when communicating in less than optimal social and environmental conditions, such as in noise, from a distance, or in a group. It may be beneficial to have individuals with PD and his/her primary communication partner(s) assess communicative effectiveness in standard situations, but also in social and environmental conditions that are unique to them and their lives (McAuliffe et al., 2010).

Overall, this study advocates for assessing hypophonia in PD from a perspective that includes the assessment of communicative effectiveness. This type of assessment will facilitate an appreciation of the impact of the speech disability associated with PD, broaden the scope of outcome measurement, and may aid the clinician in providing appropriate educational strategies to manage communication breakdown in this population. Without utilizing subjective, patient reported outcome measures, the impact of the communication disorder cannot be captured fully.

Acknowledgement

Preparation of this work was supported by a grant # R4756A02 from the Academic Development Fund at Western University.

Appendix A

In the present conversion calibration procedure, the participant wore a headset microphone (AKG c420) that was positioned 6 cm from the mouth. The audio signal from the microphone was recorded and digitized as .wav files at 44.1 kHz and 16 bits while the participant produced a calibration signal in the form of a prolonged ''ah'' vowel. While producing the prolonged vowel, the participant received instantaneous visual feedback about their speech intensity from a visual display of decibels on a sound level meter (SLM) that was positioned 15 cm from his/her mouth. The mouth-to-SLM distance was maintained at 15 cm by a plastic bar that was attached to the SLM and was kept in continuous contact with the front of the participant's chin (near the mental symphysis). The participant was asked to produce a prolonged ''ah'' vowel and use the visual feedback from the SLM to produce a stable value of 70 dB (SPL-A; fast setting). It generally took several attempts and several seconds within each attempt for the participant to successfully maintain a stable 70 dB intensity for 1–2 s. When a brief (1–2 s) stable 70 dB vowel intensity was achieved the examiner immediately said ''stop''. This stop utterance was captured in the participant's prolonged vowel audio recording and it was used to mark the end point of the calibration signal. Once the calibration audio recording of the prolonged vowel was viewed in Visipitch, the ''stop'' utterance was located on the audio file and the point before the ''stop'' utterance was marked with a cursor as the endpoint of the calibration signal. A point that was 500 ms preceding this endpoint was located in the prolonged vowel and this was marked with a cursor as the starting point of the calibration signal. The average intensity of the 500 ms calibration signal segment was measured in Visipitch and the difference between this intensity value and the 70 dB (calibration target) was calculated. This procedure was repeated until three stable 70 dB samples were obtained. The average of these three calibration values became the conversion factor, and this was used to convert all of the intensity values obtained in Visipitch to the 15 cm reference. For example, if the average of the three 70 dB calibration values obtained in Visipitch was found to be 66 dB, then a calibration factor of 4 dB (70 dB minus 66 dB) would be added to all of the participant's Visipitch-based speech intensity measures. Thus, in the present study the participants' headset microphone recordings of speech intensity were calibrated to a 70 dBA SPL SLM-based reference at 15 cm.

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