



**Speech in Individuals
with Parkinson's Disease
with and without
Deep Brain Stimulation**

Fall 2012

Introduction

Speech is one of the most fundamental means of connecting with others and expressing our wants and needs. Speech difficulties, then, can result in significant challenges when interacting with others and can result in functional challenges, social isolation, and reduced quality of life. Research has found that speech problems are common in Parkinson's disease (PD), and it has been found that 70% of persons with PD reported speech impairments after the onset of PD¹. There is much research examining speech in PD and the following paragraphs are intended to provide only a brief introduction to this topic as it relates to the current research study.

Changes in speech as it relates to PD:

- It is common for individuals with PD to experience monotonous and reduced pitch and loudness, variable rate of speech, short rushes of speech, slurred speech, and a breathy and harsh voice²⁻⁶.
- In other words, individuals with Parkinson's disease may notice changes in vocal sounds, overall expression of words, breath control during speech, speech volume (softening speech volume), and/or changes in rhythm of speech that reflect emotional expression⁷⁻⁸.

Deep Brain Stimulation (DBS) and its impact on speech:

- There has also been a growing interest in understanding "speech" in individuals with PD who have undergone DBS-STN. Although some studies have noted that DBS can help speech by improving "motor systems" involved in speech production⁹⁻¹³, such as helping individuals increase the motor force needed to produce speech and increase acoustic components of speech, the majority of studies comparing speech before and after DBS-STN have generally shown either no improvement or a decline in speech functioning following surgery¹³⁻²¹.
- Some research has found that speech intelligibility (clarity in expressive speech) worsened following DBS, and speech sounded more slurred¹³⁻¹⁹.
- DBS has also been found to have an adverse impact on intonation or rhythm, articulation, and intelligibility; the stimulation itself can cause changes in speech²⁰⁻²².
- Long-term outcome of bilateral DBS-STN found that speech functioning declined in these patients after five years²³. This result was interpreted as a reflection of the expected decline in speech that one would see in DBS-STN treated patients. DBS-STN does not appear to offer any protection against declines in speech functioning in the long-term.

Treatment for Speech Disturbance:

- Schulz and Grant conducted a review of the different treatment approaches for persons with PD and examined the effects of these treatments on speech⁸. Treatment methods reviewed included speech therapy, medication intervention, and surgical procedures. Their review showed that speech therapy (when persons with PD are optimally medicated) has proven to be the most effective therapeutic method for improving voice and speech function.
- Although there are different approaches to speech therapy, there have been several studies examining the benefits of the Lee Silverman Voice Treatment (LSVT), a behavioral treatment program for speech abnormalities.
 - In 1987 Ramig et al. developed a treatment program to improve voice and speech production in patients with Parkinson's disease. The program, LSVT, is unique in that it focuses on a simple set of voice tasks with high intensity treatment.²⁴
 - Ramig and colleagues indicated that LSVT has yielded significant long-term improvement (even up to two years) in speech and voice functions in individuals with idiopathic PD²⁵⁻²⁶.
 - Sapir, Ramig, and Fox (2011) provide a review of LSVT outcome data supporting the benefit of this speech therapy modality. With regard to the benefits of LSVT, research evidence has shown

that LSVT significantly improves laryngeal function, vocal loudness, voice quality, prosodic voice fundamental frequency (rhythm and intonation and its perceptual correlate pitch), inflection, vowel articulation, speech quality, overall speech intelligibility facial expression, swallowing and tongue function²⁷.

Objectives

1. To compare and contrast speech symptoms for **DBS** and **Non-DBS** patients in both a **Younger PD group** and **Older PD group**.
2. To compare and contrast speech symptoms for **DBS** and **Non-DBS** patients who are earlier in the course of PD (**Early PD group**) and those who are in more advanced stages of PD (**Advanced PD group**).

Methods

There were 758 individuals who participated in this survey, including 287 participants with PD who underwent DBS (**DBS group**) and 471 individuals with PD without DBS (**Non-DBS group**). Please see Table 1 for the demographic characteristics of the participants. Participants were recruited from a variety of sources. Individuals were invited to participate in the current survey based on: 1) previous survey participation; 2) response to study announcements in medical clinics around the country; 3) participation in local PD support groups advertising the study; or 4) response to survey announcements on The Parkinson Alliance website (www.parkinsonalliance.org) or our affiliate website devoted to DBS (www.dbs-stn.org). The participants completed a paper-and-pencil survey comprised of the following questionnaires:

The Demographic Questionnaire and Questions Related to Speech Symptoms:

The demographic questionnaire included questions related to background information as well as questions related to a broad range of speech symptoms. Specific speech symptoms addressed included characteristics of speech symptoms, how speech difficulties impact various aspects of life, treatment related matters, and the impact of DBS on speech (for those who have had DBS).

The Voice Handicap Index:

The Voice Handicap Index (VHI)²⁸ is a validated measure used to assess the self-perceived impact/interference of an individual's "voice disorder" on the social aspects of his or her life. This instrument consists of 30 statements regarding daily experiences encountered relating to functional, physical, and emotional issues of a voice disorder. The VHI statements correspond to self-perceptions of voice characteristics, the impact of the voice disorder on daily life, and individuals' emotional responses to the voice disorder. Examples of questions in each domain include:

Functional:

1. My voice makes it difficult for people to hear me.
2. I use the phone less often than I would like to.
3. My voice difficulties restrict personal and social life.

Physical:

1. I run out of air when I talk.
2. I feel as though I have to strain to produce voice.
3. I use a great deal of effort to speak.

Emotional:

1. I am tense when talking to others because of my voice.
2. My voice problem upsets me.
3. I am embarrassed when people ask me to repeat.

Results

There was a statistically significant difference in age and duration of PD between the **DBS group** and **Non-DBS group**, with the **DBS group** being younger (see Table 1 and Figure 1) and having a longer duration of PD on average (see Table 1 and Figure 2). Thus, the data are analyzed separately for age (younger, older) and duration of disease (early, advanced).

Table 1. Demographics and Clinical Features of the Sample

Variable	DBS (n=287)	Non-DBS (n=471)
Average Age in Years * (Range; Standard Deviation)	65 (38-90; 9.03)	70 (39-100; 9.63)
Duration of PD in Years * (Range; Standard Deviation)	16 (1-43; 6.86)	8 (0-36; 5.83)
Average Age of PD Onset * (Range; Standard Deviation)	50 (21-78; 9.98)	63 (31-93; 10.73)
Male	63%	59%
Female	37%	41%
Married	76%	77%
Living with Someone	85%	87%
Dominant Hand - Right	87%	89%
Left	11%	9%
Ambidextrous	2%	2%
Average Age at Time of DBS in Years (Range; Standard Deviation)	61 (32-85; 9.50)	n/a
Average Duration since DBS in Years (Range; Standard Deviation)	5 (0-14; 3.47)	n/a
DBS Target		
Subthalamic Nucleus (STN)	83%	n/a
Globus Pallidus interna (GPi)	12%	n/a
Thalamus	5%	n/a
Bilateral Stimulation	89%	n/a
Unilateral Stimulation	11%	n/a

* Denotes significant differences between the groups

Figure 1. Age Categories for DBS and Non-DBS groups

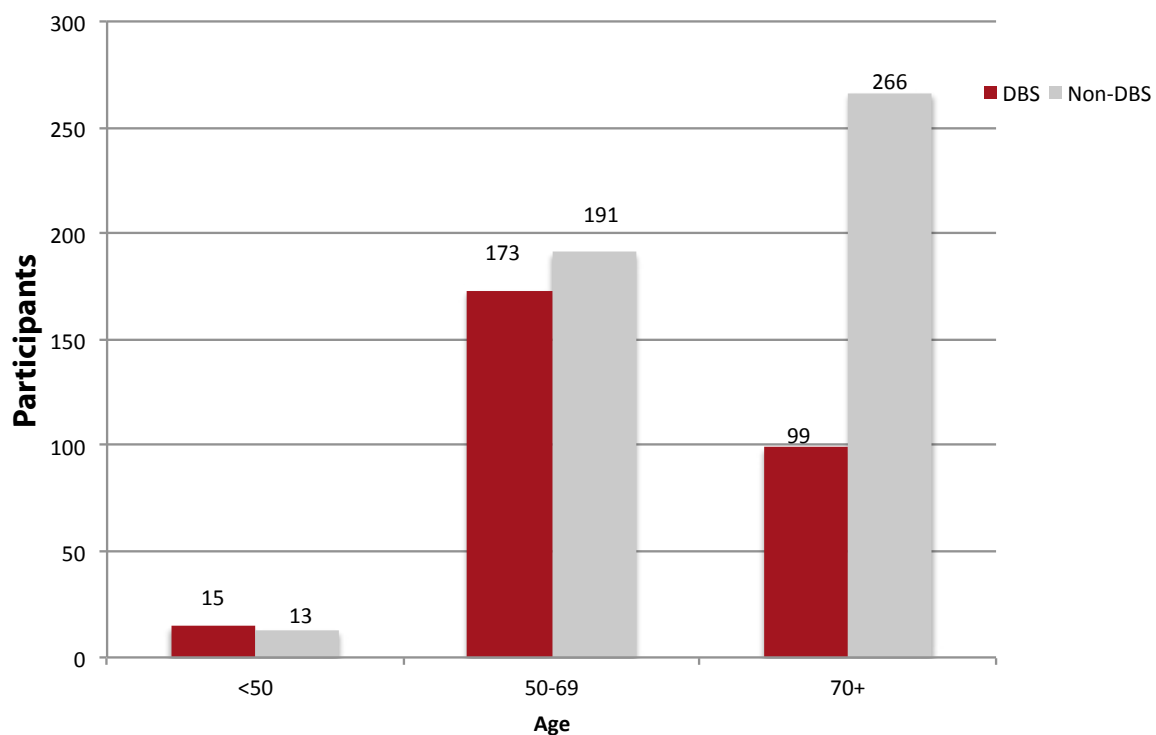
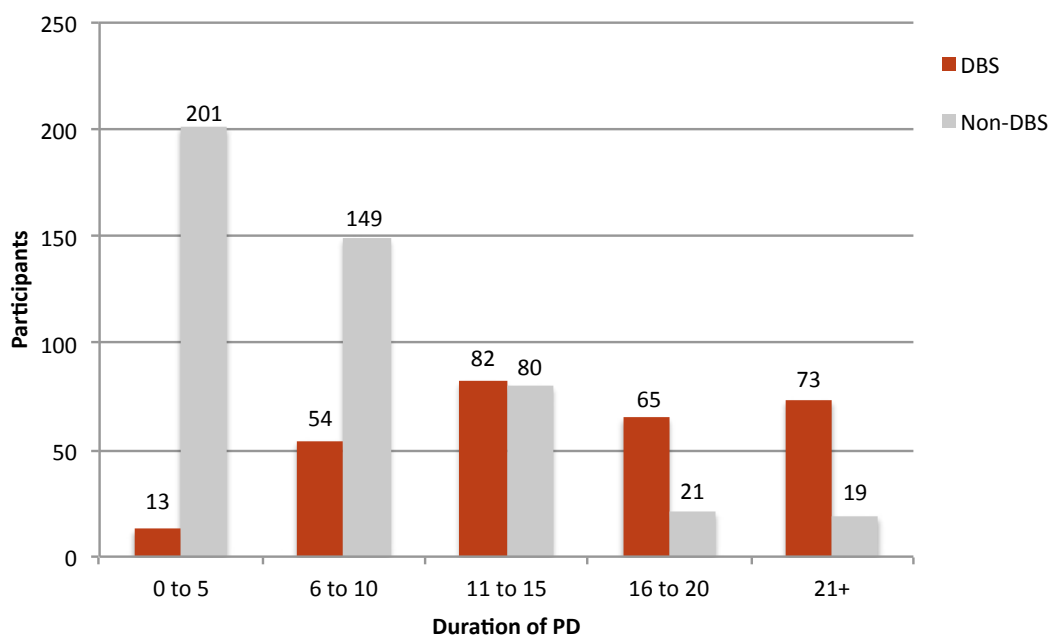


Figure 2. Disease Duration (in Years) for DBS and Non-DBS groups



SPEECH SYMPTOMS IN DBS AND NON-DBS GROUPS IN BOTH YOUNGER AND OLDER PARTICIPANTS:

Speech differences in DBS and Non-DBS Groups in YOUNGER Participants (50-69 years of age):

- In general, in the **Younger PD group**, there was a statistically significant difference between the Younger **DBS** and Younger **Non-DBS groups** on a number of reported speech difficulties (see Table 2). The **DBS group** rated their speech difficulties in a number of areas as more severe when compared to the **Non-DBS group**.
- 94% of the Younger **DBS group** reported having speech problems at the current time, with 75% characterizing the severity of their speech problems as moderate to severe.
- 74% of the Younger **Non-DBS group** reported experiencing speech difficulties at the current time, with 29% characterizing the severity of their speech problems as moderate to severe.
- Although a significant portion of both groups reported that others have difficulties understanding them, a greater number of the Younger **DBS group** reported difficulties with other people understanding them than the Younger **Non-DBS group** (**DBS group**=89%; **Non-DBS group**=59%; statistically significant difference).
- When compared to the Younger **Non-DBS group**, the Younger **DBS group** endorsed a greater reduction in communicating with others due to their speech difficulties (**DBS group**=84%; **Non-DBS group**=45%; statistically significant difference).
- Due to speech difficulties, a significantly greater number of individuals in the Younger **DBS group** reported that they were socializing less often than individuals in the Younger **Non-DBS group** (**DBS group**=79%; **Non-DBS group**=33%; statistically significant difference).

Speech differences in DBS and Non-DBS Groups in OLDER Participants (70+ years of age):

- In general, in the **Older PD group**, there was a statistically significant difference between the Older **DBS group** and Older **Non-DBS group** on a number of reported speech difficulties (see Table 2). The Older

DBS group rated their speech difficulties in a number of areas as more severe when compared to the Older **Non-DBS group**.

- 97% of the Older **DBS group** reported having speech problems at the current time, with 81% characterizing the severity of their speech problems as moderate to severe.
- 86% of the Older **Non-DBS group** reported experiencing speech difficulties at the current time, with 48% characterizing the severity of their speech problems as moderate to severe.
- Although a significant portion of both groups reported that others have difficulties understanding them, a greater number of individuals in the Older **DBS group** reported difficulties with other people understanding them when compared to the Older **Non-DBS group** (**DBS group**=95%; **Non-DBS group**=73%; statistically significant difference).
- When compared to the Older **Non-DBS group**, the Older **DBS group** endorsed a greater reduction in communicating with others due to their speech difficulties (**DBS group**=90%; **Non-DBS group**=59%; statistically significant difference).
- Due to speech difficulties, a significantly greater number of individuals in the Older **DBS group** reported that they were socializing less often than individuals in the Older **Non-DBS group** (**DBS group**=80%; **Non-DBS group**=48%; statistically significant difference).

Table 2: General questions about speech: Differences between DBS and Non-DBS Groups for Younger and Older PD Participants

Questions related to speech	Younger PD Group (50-69 yrs) (n=364)		Older PD Group (70+years) (n=365)	
	DBS (n=173)	Non-DBS (n=191)	DBS (n=99)	Non-DBS (n=266)
* Have you experienced speech difficulties since you have been diagnosed with PD?				
No	4%	18%	5%	12%
A little bit	22%	49%	14%	40%
Moderately	31%	23%	24%	28%
Quite a bit/Extremely	43%	11%	57%	20%
* How severe would you rate your current overall speech problem?				
No problems	6%	26%	3%	14%
A little bit	19%	46%	12%	38%
Moderately	40%	20%	29%	29%
Quite a bit/Extremely	35%	9%	56%	19%
* To what extent do you think other people can understand you?				
No difficulty understanding me	11%	41%	5%	27%
A little bit of difficulty	28%	38%	21%	36%
Moderate difficulty	33%	15%	21%	25%
Quite a bit/Extreme difficulty	29%	7%	52%	13%
* Are you communicating less because of speech difficulties?				
No	16%	55%	10%	41%
A little bit	33%	28%	20%	31%
Moderately	24%	13%	23%	14%
Quite a bit/Extremely	28%	4%	47%	15%

*** Do you socialize less due to speech difficulties?**

No	21%	67%	20%	52%
A little bit	33%	20%	22%	20%
Moderately	23%	6%	15%	15%
Quite a bit/Extremely	23%	6%	42%	12%

To what extent have you had difficulties communicating with others because your mind “suddenly goes blank”?

No	23%	23%	22%	19%
A little bit	38%	50%	33%	41%
Moderately	23%	14%	13%	25%
Quite a bit/Extremely	16%	13%	32%	15%

At what time of day is your speech the best?

Morning	33%	38%	29%	30%
Afternoon	9%	12%	13%	12%
Night	2%	2%	1%	3%
Variable	57%	47%	56%	55%

At what time of day is your speech the worst?

Morning	7%	8%	6%	6%
Afternoon	5%	10%	7%	7%
Night	30%	30%	33%	31%
Variable	58%	51%	52%	55%

* Statistically significant differences between the **DBS** and **Non-DBS groups** for both the **Younger** and **Older** cohorts.

Characterization of Speech Disturbance in the DBS and Non-DBS Groups in YOUNGER Participants (50-69 years of age):

- For the **Younger PD group**, there was a statistically significant difference between the **DBS** and **Non-DBS groups** on numerous speech symptoms. Specifically, the **Younger DBS group** endorsed problems with slurred speech, low volume, festinating speech (the expression of words that accelerates while talking, and the space between words becomes shorter and shorter), speaking rapidly, initiating speech, monotone voice, and swallowing in greater frequency than the **Younger Non-DBS group** (see Table 3).
- The speech symptom demonstrating the greatest discrepancy between the **Younger DBS** and **Non-DBS groups** was slurred speech, which was a statistically significant difference. A significantly larger percentage of the **DBS group** endorsed slurred speech when compared to the **Non-DBS group**.
- The most frequently endorsed “most troubling type of speech disturbance” for the **Younger DBS group** was low volume, followed by slurred speech and word-finding difficulties (See Table 4).
- The most frequently endorsed “most troubling type of speech disturbance” for the **Younger Non-DBS group** was low volume, followed by word-finding difficulties (See Table 4).

Characterization of Speech Disturbance in the DBS and Non-DBS Groups in OLDER Participants (70+ years of age):

- For the **Older PD group**, there was a statistically significant difference between the **DBS** and **Non-DBS groups** on numerous speech symptoms (see Table 3). Specifically, the **older DBS group** endorsed problems with slurred speech, low volume, festinating speech (the expression of words that accelerates while talking, and the space between words becomes shorter and shorter), speaking rapidly, initiating speech, and swallowing in greater frequency than the **older Non-DBS group**. The **older Non-DBS group** endorsed word-finding difficulties in greater frequency than the **DBS group**.
- The speech symptom demonstrating the greatest discrepancy between the **older DBS** and **older Non-DBS groups** was slurred speech, which was a statistically significant difference. A significantly larger percentage of the **older DBS group** endorsed slurred speech when compared to the **older Non-DBS group**.

- The most frequently endorsed “most troubling type of speech disturbance” for the **DBS group** was low volume, followed by swallowing, slurred speech and word-finding difficulties (See Table 4).
- The most frequently endorsed “most troubling type of speech disturbance” for the **Non-DBS group** was low volume, followed by word-finding difficulties (See Table 4).

Table 3. Percentage of DBS and Non-DBS Groups for Younger and Older PD Participants Endorsing Specific Speech Difficulties

Description of Speech Difficulty	Younger PD Group		Older PD Group	
	DBS (n=173)	Non-DBS (n=191)	DBS (n=99)	Non-DBS (n=266)
Slurred Speech *,**	74%	34%	61%	34%
Low Volume *,**	88%	72%	86%	77%
Hoarseness in Speech	40%	37%	35%	43%
Festinating Speech *,**	29%	11%	27%	13%
Rapid Speech *,**	22%	11%	22%	11%
Tremulous Speech	13%	13%	11%	16%
Difficulty Getting Started *,**	33%	24%	38%	28%
Monotone Speech *	47%	27%	34%	33%
Stuttering	22%	15%	17%	12%
Word-finding Difficulties **	53%	62%	50%	60%
Swallowing *,**	51%	34%	64%	39%

* Statistically significant differences between the **DBS** and **Non-DBS groups** in the **Younger PD group**.

** Statistically significant differences between the **DBS** and **Non-DBS groups** in the **Older PD group**.

Table 4. Most Troubling Speech Symptom Endorsed for the DBS and Non-DBS Groups as it relates to the Younger and Older PD Participants

Most Troubling Symptom	Younger PD Group		Older PD Group	
	DBS (n=173)	Non-DBS (n=191)	DBS (n=99)	Non-DBS (n=266)
Slurred Speech *,**	25%	7%	19%	6%
Low Volume	34%	30%	39%	34%
Hoarseness in Speech	5%	7%	7%	5%
Festinating Speech	3%	2%	1%	1%
Rapid Speech **	2%	2%	9%	1%
Tremulous Speech	2%	2%	0%	2%
Difficulty Getting Started **	2%	2%	8%	3%
Monotone Speech **	4%	4%	7%	1%
Stuttering	5%	4%	2%	2%
Word-finding Difficulties *	14%	26%	16%	23%
Swallowing **	5%	6%	12%	5%

* Statistically significant differences between the **DBS** and **Non-DBS groups** in the **Younger PD group**.

** Statistically significant differences between the **DBS** and **Non-DBS groups** in the **Older PD group**.

Voice Handicap Index (VHI) for the DBS and Non-DBS Groups within Younger and Older PD Groups:

The domains within the Voice Handicap Index (VHI; Functional Speech, Physical Speech, Emotional Impact of Speech Disturbance, and the Total Score) revealed statistically significant differences between the **DBS group** and the **Non-DBS group** in both a **Younger PD group** and **Older PD group** in each domain (see Figures 3 and 4).

Examples of functional, physical, and emotional aspects to speech based on the VHI:

Functional:

1. My voice makes it difficult for people to hear me.
2. I use the phone less often than I would like to.
3. My voice difficulties restrict personal and social life.

Physical:

1. I run out of air when I talk.
2. I feel as though I have to strain to produce voice.
3. I use a great deal of effort to speak.

Emotional:

1. I am tense when talking to others because of my voice.
2. My voice problem upsets me.
3. I am embarrassed when people ask me to repeat.

Voice Handicap Index (VHI) in YOUNGER Participants (50-69 years of age; See Figure 3):

- For each subsection of the VHI, the average rating of speech disturbance for each group revealed:
 - Younger **DBS** participants had a higher rating of “functional” voice disturbance than the Younger **Non-DBS** group (**DBS group:** Mean: 18.90; Standard Deviation: 9.33; **Non-DBS group:** Mean: 9.92; Standard Deviation: 8.63).
 - Younger **DBS** participants had a higher rating of “physical” voice disturbance than the Younger **Non-DBS** group (**DBS group:** Mean: 16.87; Standard Deviation: 8.67; **Non-DBS group:** Mean: 9.64; Standard Deviation: 8.12).
 - Younger **DBS** participants had a higher rating of “emotional disturbance” in response to their voice problems when compared to the Younger **Non-DBS** group (**DBS group:** Mean: 15.45; Standard Deviation: 10.52; **Non-DBS group:** Mean: 7.99; Standard Deviation: 8.94).
 - Younger **DBS** had a “Total Score” (the sum of the Functional, Physical, and Emotional domains) that was higher than the Younger **Non-DBS** group, indicating that individuals with **DBS** reported higher ratings of “voice disturbance/interference” when compared to the **Non-DBS** group (**DBS group:** Mean: 51.23; Standard Deviation: 26.26; **Non-DBS group:** Mean: 27.54; Standard Deviation: 24.01).

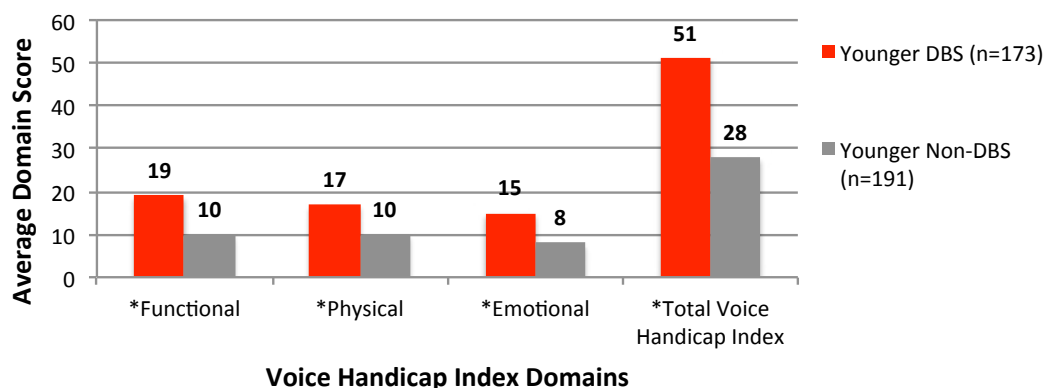
Voice Handicap Index (VHI) in OLDER Participants (70+ years of age; See Figure 4):

- For each subsection of the VHI, the average rating of speech disturbance for each group revealed:
 - Older **DBS** participants had a higher rating of “functional” voice disturbance than the Older **Non-DBS** group (**DBS group:** Mean: 19.89; Standard Deviation: 10.63; **Non-DBS group:** Mean: 12.12; Standard Deviation: 8.82).
 - Older **DBS** participants had a higher rating of “physical” voice disturbance than the Older **Non-DBS** group (**DBS group:** Mean: 17.31; Standard Deviation: 9.15; **Non-DBS group:** Mean: 11.00; Standard Deviation: 8.22).

- Older **DBS** participants had a higher rating of “emotional disturbance” in response to their voice problems when compared to the Older **Non-DBS** group (**DBS group**: Mean: 16.86; Standard Deviation: 11.57; **Non-DBS group**: Mean: 9.10; Standard Deviation: 9.19).
- Older **DBS** had a “Total Score” (the sum of the Functional, Physical, and Emotional domains) that was higher than the Older **Non-DBS** group, indicating that individuals with **DBS** reported higher ratings of “voice disturbance/interference” when compared to the **Non-DBS** group (**DBS group**: Mean: 54.05; Standard Deviation: 29.13; **Non-DBS group**: Mean: 32.22; Standard Deviation: 24.51).

Figure 3. Voice Handicap Index (VHI):

Differences between DBS and Non-DBS in a YOUNGER PD Group

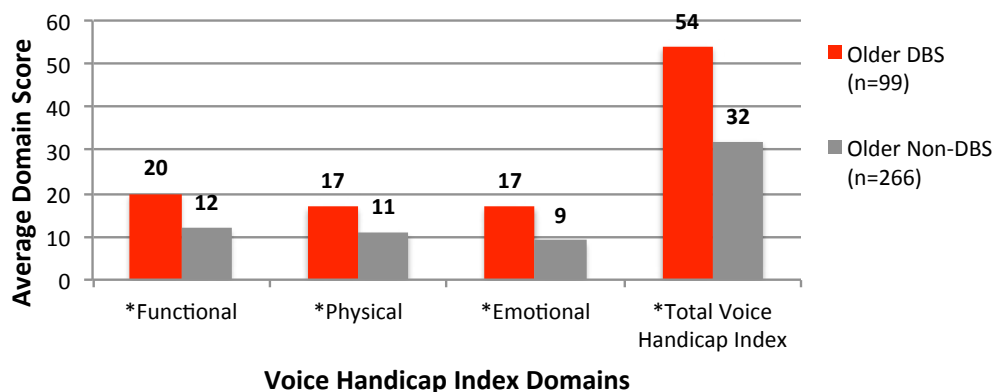


Higher scores reflect greater interference from speech/voice difficulties

* Statistically significant difference between groups

Figure 4. Voice Handicap Index (VHI):

Differences between DBS and Non-DBS in an OLDER PD Group



Higher scores reflect greater interference from speech/voice difficulties

* Statistically significant difference between groups

SPEECH SYMPTOMS IN DBS AND NON-DBS GROUPS IN BOTH EARLY AND ADVANCED PD PARTICIPANTS:

Early versus Advanced PD:

To look closer at the influence of disease duration on non-motor symptoms, the participants in this study were divided into the groups “**Early PD group**” and “**Advanced PD group**.” Previous research has found that in PD the

average time from symptom onset to development of motor complications was 6 years^{27,28}. Thus, based on previous research, the participants in this study were divided into the groups **Early** versus **Advanced PD**, <6 years and 6+ years, respectively, to define a valid partition between early and advanced disease states^{29, 30}.

There were too few individuals who have **DBS** therapy in the **Early PD group** (disease duration of < 6 years) to compare **DBS** versus **Non-DBS** participants (**DBS**: N=13; **Non-DBS**: N=201). The small number of individuals with **DBS** in the **Early PD group** can be explained by DBS candidacy standards. Moreover, several of the world experts in DBS therapy for PD patients convened in 2009 to establish an “Expert Consensus and Review of Key Issues” related to DBS for PD³¹. This group of individuals indicated that DBS therapy is most commonly offered as a treatment intervention after an individual has had PD for more than 5 years. Consequently, due to the small number of **DBS** participants in the **Early PD group** in this study, analyses comparing **DBS** versus **Non-DBS** participants in the **Early PD group** were not conducted.

The **Advanced PD group** was divided into two groups (**Advanced PD 6-10 years** and **Advanced PD 11+ years**) to take a closer look at disease duration and its impact on speech within these cohorts.

Speech differences in DBS and Non-DBS Groups in ADVANCED PD 6-10 YEARS:

- In general, in the **Advanced PD group 6-10 years**, there were numerous statistically significant differences in speech disturbance severity between the **DBS group** and **Non-DBS group**, with the **DBS group** reporting more severe symptoms (see Table 5).
- 93% of the Advanced PD 6-10 years **DBS group** reported having speech problems at the current time, with 74% characterizing the severity of their speech problems as moderate to severe.
- 85% of the Advanced PD 6-10 years **Non-DBS group** reported experiencing speech difficulties at the current time, with 42% characterizing the severity of their speech problems as moderate to severe.
- Although a significant portion of both Advanced PD 6-10 years **DBS** and **Non-DBS groups** reported that others have difficulties understanding them, a larger percentage of the **DBS group** reported greater difficulties with other people understanding them than the **Non-DBS group** (**DBS group**=93%; **Non-DBS group**=75%; statistically significant difference).
- When compared to the Advanced PD 6-10 years **Non-DBS group**, the Advanced PD 6-10 years **DBS group** endorsed a greater reduction in communicating with others due to their speech difficulties (**DBS group**=80%; **Non-DBS group**=60%; statistically significant difference).
- Due to speech difficulties, a significantly greater number of individuals in the Advanced PD 6-10 years **DBS group** reported that they were socializing less often than individuals in the Advanced PD 6-10 years **Non-DBS group** (**DBS group**=78%; **Non-DBS group**=44%; statistically significant difference).

Speech differences in DBS and Non-DBS Groups in ADVANCED PD 11+ YEARS):

- In general, in the **Advanced PD 11+ years group**, there were numerous statistically significant differences in speech disturbance severity between the **DBS group** and **Non-DBS group**, with the **DBS group** reporting more severe symptoms (see Table 5).
- 96% of the Advanced PD 11+ years **DBS group** reported having speech problems at the current time, with 81% characterizing the severity of their speech problems as moderate to severe.
- 90% of the Advanced PD 11+ years **Non-DBS group** reported experiencing speech difficulties at the current time, with 52% characterizing the severity of their speech problems as moderate to severe.
- Although a significant portion of both groups reported that others have difficulties understanding them, a larger percentage of the Advanced PD 11+ years **DBS group** reported greater difficulties with other people understanding them than the Advanced PD 11+ years **Non-DBS group** (**DBS group**=92%; **Non-DBS group**=74%; statistically significant difference).

- When compared to the Advanced PD 11+ years **Non-DBS group**, the Advanced PD 11+ years **DBS group** endorsed a greater reduction in communicating with others due to their speech difficulties (**DBS group**=88%; **Non-DBS group**=64%; statistically significant difference).
- Due to speech difficulties, a significantly greater number of individuals in the Advanced PD 11+ years **DBS group** reported that they were socializing less often than individuals in the Advanced PD 11+ years **Non-DBS group** (**DBS group**=80%; **Non-DBS group**=52%; statistically significant difference).

Table 5. Speech Symptoms Advanced PD Group 6-10 years versus Advanced PD Group 11+ Years: DBS vs. Non-DBS

Questions related to speech	Advanced PD Group 6-10yrs (n=202)		Advanced PD Group 11+yrs (n=340)	
	DBS (n=54)	Non-DBS (n=148)	DBS (n=220)	Non-DBS (n=120)
* Have you experienced speech difficulties since you have been diagnosed with PD?				
No	2%	10%	5%	9%
A little bit	30%	45%	16%	39%
Moderately	43%	25%	26%	36%
Quite a bit/Extremely	26%	19%	54%	17%
* How severe would you rate your current overall speech problem?				
No problems	7%	15%	4%	10%
A little bit	19%	43%	15%	38%
Moderately	56%	23%	30%	34%
Quite a bit/Extremely	19%	19%	50%	18%
* To what extent do you think other people can understand you?				
No difficulty understanding me	7%	25%	8%	26%
A little bit of difficulty	39%	41%	22%	33%
Moderate difficulty	35%	23%	26%	28%
Quite a bit/Extreme difficulty	19%	12%	44%	14%
* Are you communicating less because of speech difficulties?				
No	20%	40%	12%	36%
A little bit	43%	36%	24%	29%
Moderately	20%	11%	25%	21%
Quite a bit/Extremely	17%	13%	39%	14%
* Do you socialize less due to speech difficulties?				
No	22%	56%	20%	48%
A little bit	43%	23%	24%	20%
Moderately	20%	12%	23%	13%
Quite a bit/Extremely	15%	8%	34%	18%
To what extent have you had difficulties communicating with others because your mind “suddenly goes blank”?				
No	20%	23%	22%	16%
A little bit	44%	43%	33%	47%
Moderately	15%	19%	22%	24%
Quite a bit/Extremely	20%	16%	24%	13%

At what time of day is your speech the best?

Morning	40%	33%	29%	32%
Afternoon	13%	15%	10%	9%
Night	4%	2%	1%	3%
Variable	43%	50%	60%	57%

At what time of day is your speech the worst?

Morning	8%	7%	7%	6%
Afternoon	6%	10%	7%	9%
Night	38%	30%	28%	34%
Variable	49%	54%	59%	51%

* Statistically significant differences between the **DBS** and **Non-DBS** groups for both **Advanced PD 6-10 years** and **Advanced PD 11+ years** groups

Characterization of Speech Disturbance in the DBS and Non-DBS Groups in the ADVANCED PD 6-10 YEARS Group

- In the **Advanced PD 6-10 years** group, there was a statistically significant difference between the **DBS** and **Non-DBS** groups on several speech symptoms. Specifically, the **DBS** group endorsed problems with slurred speech, festinating speech (the expression of words that accelerates while talking, and the space between words becomes shorter and shorter), speaking rapidly, and stuttering in greater frequency than the **Non-DBS** group (see Table 6).
- The speech symptom demonstrating the greatest discrepancy between the Advanced PD 6-10 years **DBS** and **Non-DBS** groups was slurred speech, which was a statistically significant difference. A significantly larger percentage of the **DBS** group endorsed slurred speech when compared to the **Non-DBS** group.
- The most frequently endorsed “most troubling type of speech disturbance” for the Advanced PD 6-10 years **DBS** group was low volume, followed by word-finding difficulties and slurred speech (See Table 7).
- The most frequently endorsed “most troubling type of speech disturbance” for the Advanced PD 6-10 years **Non-DBS** group was low volume, followed by word-finding difficulties (See Table 7).

Characterization of Speech Disturbance in the DBS and Non-DBS Groups in the ADVANCED PD 11+ YEARS Group

- In the **Advanced PD 11+ years** group, there was a statistically significant difference between the **DBS** and **Non-DBS** groups on numerous speech symptoms. Specifically, the **DBS** group endorsed problems with slurred speech, festinating speech (the expression of words that accelerates while talking, and the space between words becomes shorter and shorter), speaking rapidly, initiating speech, and swallowing in greater frequency than the **Non-DBS** group (see Table 3). The **Non-DBS** group endorsed word-finding difficulties in greater frequency than the **DBS** group.
- The speech symptom demonstrating the greatest discrepancy between the Advanced PD 11+ years **DBS** and **Non-DBS** groups was slurred speech, which was a statistically significant difference. A significantly larger percentage of the **DBS** group endorsed slurred speech when compared to the **Non-DBS** group.
- The most frequently endorsed “most troubling type of speech disturbance” for the Advanced PD 11+ years **DBS** group was low volume, followed by slurred speech and word-finding difficulties (See Table 7).
- The most frequently endorsed “most troubling type of speech disturbance” for the Advanced PD 11+ years **Non-DBS** group was low volume, followed by word-finding difficulties (See Table 4).

Table 6. Percentage of DBS and Non-DBS Groups within the Advanced PD Group 6-10 years and the Advanced PD Group 11+Years Endorsing Specific Speech Difficulties:

Description of Speech Difficulty	Advanced PD group 6-10yrs		Advanced PD Group 11+ yrs	
	DBS (n=54)	Non-DBS (n=148)	DBS (n=220)	Non-DBS (n=120)
Slurred Speech *,**	80%	40%	68%	41%
Low Volume	89%	80%	86%	85%
Hoarseness in Speech	54%	41%	36%	39%
Festinating Speech *,**	22%	11%	32%	19%
Rapid Speech *,**	24%	12%	25%	13%
Tremulous Speech	13%	14%	13%	17%
Difficulty Getting Started **	28%	28%	38%	28%
Monotone Speech	41%	34%	42%	36%
Stuttering *	20%	10%	20%	15%
Swallowing **	48%	41%	56%	36%
Word-finding Difficulties **	61%	61%	51%	62%

* Statistically significant differences between the **DBS and Non-DBS for the Advanced PD 6-10 years group**.

** Statistically significant differences between the **DBS and Non-DBS for the Advanced PD 11+ years group**.

Table 7. Most Troubling Speech Symptom Endorsed for the DBS and Non-DBS Groups within the Advanced PD Group 6-10 years and the Advanced PD Group 11+Years:

Most Troubling Symptom	Advanced PD group 6-10yrs		Advanced PD Group 11+ yrs	
	DBS (n=54)	Non-DBS (n=148)	DBS (n=220)	Non-DBS (n=120)
Slurred Speech *,**	20%	5%	22%	8%
Low Volume	32%	31%	37%	43%
Hoarseness in Speech	7%	8%	4%	3%
Festinating Speech *	7%	0%	2%	2%
Rapid Speech *	7%	0%	4%	3%
Tremulous Speech	2%	0%	1%	4%
Difficulty Getting Started	0%	1%	5%	3%
Monotone Speech	4%	1%	5%	3%
Stuttering	2%	3%	4%	3%
Swallowing	11%	5%	7%	8%
Word-finding Difficulties	28%	25%	13%	19%

* Statistically significant differences between the **DBS and Non-DBS for the Advanced PD 6-10 years group**.

** Statistically significant differences between the **DBS and Non-DBS for the Advanced PD 11+ years group**.

Voice Handicap Index (VHI) for the Advanced PD groups (disease duration 6-10 years and 11+years)

The domains within the Voice Handicap Index (VHI; Functional Speech, Physical Speech, Emotional Impact of Speech Disturbance, and the Total Score) revealed significant differences between the **DBS group** and the **Non-DBS group** in both **Advanced PD 6-10 years group** and **Advanced PD 11+ years group** (see Figures 3 and 4).

Examples of functional, physical, and emotional aspects of speech based on the VHI:

Functional:

1. My voice makes it difficult for people to hear me.
2. I use the phone less often than I would like to.
3. My voice difficulties restrict personal and social life.

Physical:

1. I run out of air when I talk.
2. I feel as though I have to strain to produce voice.
3. I use a great deal of effort to speak.

Emotional:

1. I am tense when talking to others because of my voice.
2. My voice problem upsets me.
3. I am embarrassed when people ask me to repeat.

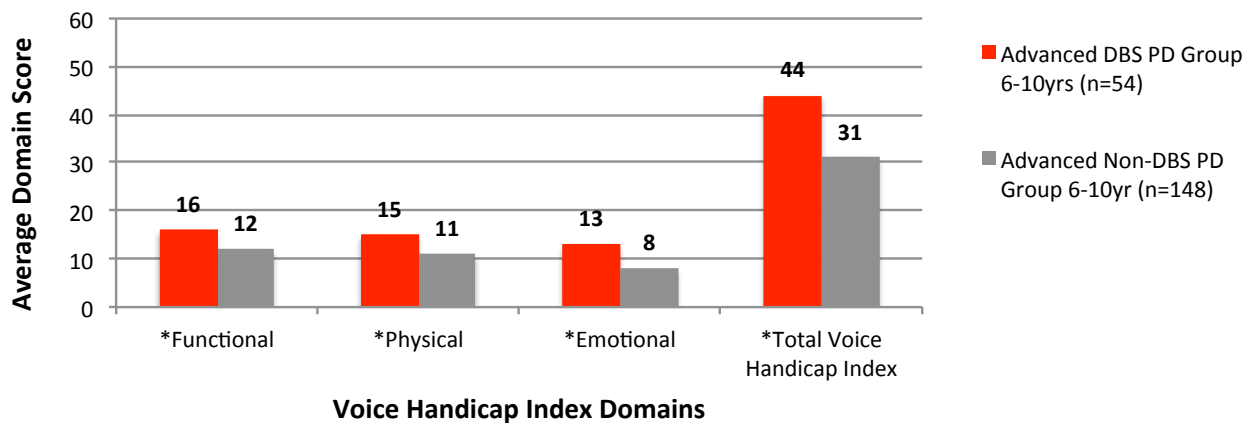
Voice Handicap Index (VHI) in Advanced PD Group 6-10 years (See Figure 5):

- For each subsection of the VHI, the average rating of speech disturbance for each group revealed:
 - Advanced PD 6-10 years **DBS** participants had a higher rating of “functional” voice disturbance than the **Non-DBS** group (**DBS group:** Mean: 15.59; Standard Deviation: 8.36; **Non-DBS group:** Mean: 11.89; Standard Deviation: 8.66).
 - Advanced PD 6-10 years **DBS** participants had a higher rating of “physical” voice disturbance than the Advanced PD 6-10 years **Non-DBS** group (**DBS group:** Mean: 15.46; Standard Deviation: 8.23; **Non-DBS group:** Mean: 10.68; Standard Deviation: 7.91).
 - Advanced PD 6-10 years **DBS** participants had a higher rating of “emotional disturbance” in response to their voice problems when compared to the Advanced PD 6-10 years **Non-DBS** group (**DBS group:** Mean: 13.33; Standard Deviation: 11.01; **Non-DBS group:** Mean: 8.43; Standard Deviation: 9.00).
 - Advanced PD 6-10 years **DBS** had a “Total Score” (the sum of the Functional, Physical, and Emotional domains) that was higher than the Advanced PD 6-10 years **Non-DBS** group, indicating that individuals with **DBS** reported higher ratings of “voice disturbance/interference” when compared to the **Non-DBS** group (**DBS group:** Mean: 44.39; Standard Deviation: 25.67; **Non-DBS group:** Mean: 30.99; Standard Deviation: 23.63).

Voice Handicap Index (VHI) in Advanced PD Group 11+ years (See Figure 6):

- For each subsection of the VHI, the average rating of speech disturbance for each group revealed:
 - Advanced PD 11+ years **DBS** participants had a higher rating of “functional” voice disturbance than the **Non-DBS** group (**DBS group:** Mean: 20.16; Standard Deviation: 10.12; **Non-DBS group:** Mean: 13.58; Standard Deviation: 8.90).
 - Advanced PD 11+ years **DBS** participants had a higher rating of “physical” voice disturbance than the Advanced PD 11+ years **Non-DBS** group (**DBS group:** Mean: 17.45; Standard Deviation: 9.09; **Non-DBS group:** Mean: 11.88; Standard Deviation: 8.10).
 - Advanced PD 11+ years **DBS** participants had a higher rating of “emotional disturbance” in response to their voice problems when compared to the Advanced PD 11+ years **Non-DBS** group (**DBS group:** Mean: 16.46; Standard Deviation: 10.91; **Non-DBS group:** Mean: 10.80; Standard Deviation: 9.52).
 - Advanced PD 11+ years **DBS** had a “Total Score” (the sum of the Functional, Physical, and Emotional domains) that was higher than the Advanced PD 11+ years **Non-DBS** group, indicating that individuals with **DBS** reported higher ratings of “voice disturbance/interference” when compared to the **Non-DBS** group (**DBS group:** Mean: 54.07; Standard Deviation: 27.72; **Non-DBS group:** Mean: 36.27; Standard Deviation: 24.56).

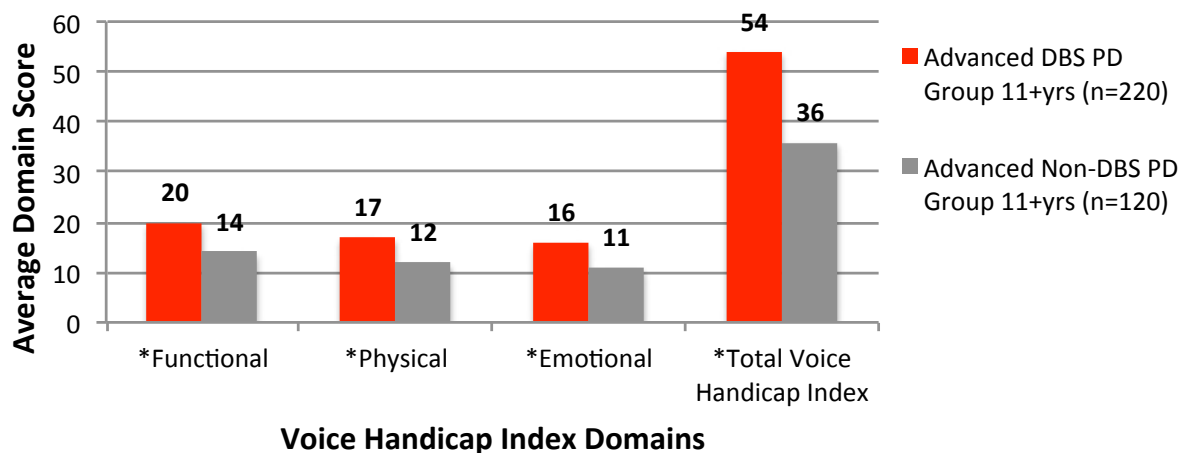
Figure 5. Voice Handicap Index (VHI): Differences between DBS and Non-DBS in Advanced PD Group 6-10yrs



Higher scores reflect greater interference from speech/voice difficulties

* Significant difference between groups

Figure 6. Voice Handicap Index (VHI): Differences between DBS and Non-DBS in Advanced PD Group 11+ yrs



Higher scores reflect greater interference from speech/voice difficulties

* Significant difference between groups

Speech disturbance and Time of Day for both Younger and Older Groups and Advanced PD 6-10 years and Advanced PD 11+ years groups:

- There were no differences between the **DBS and Non-DBS groups** in the **Younger and Older PD groups** and **Advanced PD 6-10 years** and **Advanced PD 11+ years groups** as it relates to the time of day that their speech is the best or worst.
- Approximately half of the individuals in the **DBS and Non-DBS groups** in the **Younger and Older PD groups** and **Advanced PD 6-10 years** and **Advanced PD 11+ years groups** indicated that their speech difficulties were variable across the day.
- Approximately one-third of the individuals in the **DBS and Non-DBS groups** in the **Younger and Older PD groups** and **Advanced PD 6-10 years** and **Advanced PD 11+ years groups** reported that their speech was the best in the morning and the worst in the evening.

SPEECH/VOICE DIFFICULTIES OVER TIME: VOICE HANDICAP INDEX (VHI): 2008 and 2012:

The Parkinson Alliance conducted a survey-based study of speech in 2008, and there were 112 participants from that study who also completed the current survey (**DBS group=57; Non-DBS group=55**).

- In general, for the participants who participated in both the 2008 and 2012 surveys, the **DBS group** rated greater speech/voice difficulties (“Functional,” “Physical,” and “Emotional”) when compared to the **Non-DBS group**.
- Both **DBS** and **Non-DBS** participants had statistically significant worsening “functional speech” over time (e.g., My voice difficulties restrict personal and social life).
- Patients in the **Non-DBS group** reported greater worsening of “functional speech” over time when compared to the **DBS group**, which was statistically significant.
- The **Non-DBS group** had a statistically significant greater decline in “physical speech functions” (e.g., I feel as though I have to strain to produce voice; I use a great deal of effort to speak) when compared to the **DBS group**.
- There was not a significant change in “emotional reactivity/disturbance” (e.g., I am tense when talking to others because of my voice; My voice problem upsets me) in response to voice difficulties over time for either group.

DBS SPECIFIC QUESTIONS:

- 66% of the DBS participants perceive that their speech got worse due to DBS.
- 17% reported that their speech was somewhat improved following DBS; 10% believe their speech was moderately improved following DBS; 7% reported that their speech greatly improved following DBS.
- 50% of the participants reported that the worsening of speech following DBS was unexpected.
- For those who perceived worsening of speech to be attributed to DBS, low volume, slurred speech, word-finding difficulties, and swallowing were the symptoms most frequently endorsed as being adversely impacted by DBS therapy.
- Adjustments to DBS settings are thought to have an impact on speech symptoms.
 - 12% of the participants believed speech worsened.
 - 48% of the participants did not believe adjustments to the DBS settings had an impact on speech.
 - 11% of the participants believed that speech improved following adjustments to the DBS settings.
 - 29% of the participants reported that speech sometimes improved and sometimes worsened following adjustments to the DBS settings.
- When the intent of adjusting DBS settings was to improve speech, 19% reported that symptoms improved.
- For those whose speech improved following the adjustment to DBS settings, 20% reported that other symptoms got worse; thus there was a trade off.
- 94% of the participants indicated that they are satisfied with the outcome of their DBS therapy based on the symptom improvement received from DBS, even in the context of having some side effects.
 - 18% reported that they were somewhat satisfied with the outcome of their DBS therapy.
 - 36% reported that they were very satisfied with the outcome of their DBS therapy.
 - 40% reported that they were extremely satisfied with the outcome of their DBS therapy.
 - 6% reported that they were not satisfied with the outcome of their DBS therapy.
- 97% of the participants reported that DBS improved their quality of life.
 - 33% reported “extreme” improvement in quality of life.
 - 38% reported “quite-a-bit” of improvement in quality of life.
 - 17% reported having “moderate” improvement in quality of life.
 - 9% reported having “a little bit” of improvement in quality of life.
 - 3% reported having no improvement in quality of life.

TREATMENT FOR SPEECH DIFFICULTIES IN PARKINSON'S DISEASE:

- Lee Silverman Voice Treatment (LSVT) uses voice training techniques that are intended to help patients with PD increase intelligibility and vocal loudness. LSVT is administered in 16 individual one-hour treatment sessions in one month. There are daily homework and daily carryover exercises all 30 days of the month. LSVT focuses exclusively on exercises (maximum sustained 'ah', high/low pitch range) as well as increasing healthy vocal loudness in functional speech production.
- 25% of the participants in this study reported that they participated in LSVT (the treatment method was explained in the survey).
- For those who participated in LSVT, 53% reported that this treatment was a little bit to moderately helpful, and 41% reported that this treatment was quite a bit to extremely helpful.
- 20% of the participants indicated that they participated in Speech Therapy, but to their knowledge, the treatment was not officially LSVT.
- 69% reported that this treatment was a little bit to moderately helpful, and 19% reported that this treatment was quite a bit to extremely helpful.

Summary and Discussion

Speech disturbance is commonly reported by people with PD, and impacts the daily lives of these individuals. Deep Brain Stimulation (DBS) has been found to adversely impact speech in a number of PD patients. Speech characteristics related to functional and psychosocial outcomes for these patients, however, require further delineation, highlighting implications for DBS therapy and expectation management. The results of this study are discussed below in the context of the objectives of this report.

1. To compare and contrast speech symptoms for **DBS** and **Non-DBS** patients in both a **Younger PD group (50-69 years of age)** and **Older PD group (70+ years)**.

- 86% of the participants of this study endorsed speech problems.
- For both the **Younger** and **Older PD groups**, there were statistically significant differences in speech disturbance severity between the **DBS group** and **Non-DBS group**, with the **DBS group** reporting more severe symptoms.
 - For the **Younger PD group**, 75% of the **DBS group** versus 29% of the **Non-DBS group** characterized the severity of their speech problems as moderate to severe.
 - For the **Older PD group**, 81% of the **DBS group** versus 48% of the **Non-DBS group** characterized the severity of their speech problems as moderate to severe.
- Although there are numerous manifestations of speech disturbances in PD, low volume was the most common and the “most troubling speech symptom” for **DBS** and **Non-DBS** participants in both **Younger** and **Older PD groups**.
- In both **Younger** and **Older PD groups**, slurred speech is one of the most common speech symptoms and appears to be the symptom most impacted by DBS.
- Swallowing difficulties were also highly endorsed by both groups, with the frequency of swallowing difficulties being greater in the **DBS group** when compared to the **Non-DBS group**.
- In both **Younger** and **Older PD groups**, the **DBS group**, when compared to the **Non-DBS group**, had higher ratings of voice disturbance that interfered with their daily life, and the **DBS group** endorsed communicating and socializing less often than the **Non-DBS group** due to speech difficulties. The **DBS group** also reported having greater emotional difficulties in response to their voice problems.

2. To compare and contrast speech symptoms for **DBS** and **Non-DBS** participants as it relates to disease duration.

* There were too few DBS participants in **Early PD group**, and consequently, analyses comparing **DBS** and **Non-DBS** groups in the **Early PD group** could not be conducted. The **Advanced PD group** was divided into two groups (**Advanced PD 6-10 years** and **Advanced PD 11+ years**) to take a closer look at disease duration and its impact on speech within these cohorts.

- For both the **Advanced PD 6-10 years group** and **Advanced PD 11+ years group**, there were statistically significant differences in speech disturbance severity between the **DBS group** and **Non-DBS group**, with the **DBS group** reporting more severe symptoms.
 - For the **Advanced PD 6-10 years group**, 74% of the **DBS group** versus 42% of the **Non-DBS group** characterized the severity of their speech problems as moderate to severe.
 - For the **Advanced PD 11+ years**, 81% of the **DBS group** versus 52% of the **Non-DBS group** characterized the severity of their speech problems as moderate to severe.
- Low volume was the most common and the “most troubling speech symptom” for **DBS** and **Non-DBS** participants in both the **Advanced PD 6-10 years group** and **Advanced PD 11+ years group**.
- In both the **Advanced PD 6-10 years group** and **Advanced PD 11+ years group**, slurred speech is one of the most common speech symptoms and appears to be the symptom most impacted by DBS.
- Swallowing difficulties were also highly endorsed by both groups, with the frequency of swallowing difficulties being greater in the **DBS group** when compared to the **Non-DBS group**.
- In both **Advanced PD 6-10 years group** and **Advanced PD 11+ years group**, the **DBS group**, when compared to the **Non-DBS group**, had higher ratings of voice disturbance that interfered with their daily life, and the **DBS group** endorsed communicating and socializing less often than the **Non-DBS group** due to speech difficulties. The **DBS group** also reported having greater emotional difficulties in response to their voice problems.

Speech disturbance and Time of Day for both Younger and Older Groups and Advanced PD 6-10 years and Advanced PD 11+ years groups:

- There were no differences between the **DBS** and **Non-DBS groups** in the **Younger** and **Older PD groups** and **Advanced PD 6-10 years** and **Advanced PD 11+ years groups** as it relates to the time of day that their speech is the best or worst.
- Approximately half of the individuals in the **DBS** and **Non-DBS groups** in the **Younger** and **Older PD groups** and **Advanced PD 6-10 years** and **Advanced PD 11+ years groups** indicated that their speech difficulties were variable across the day.
- Approximately one-third of the individuals in the **DBS** and **Non-DBS groups** in the **Younger** and **Older PD groups** and **Advanced PD 6-10 years** and **Advanced PD 11+ years groups** reported that their speech was the best in the morning and the worst in the evening.

DBS Highlights:

- Although 34% of the individuals whose speech was affected by DBS indicated that they experienced improvement in speech symptoms following DBS, 66% of the DBS participants perceive that their speech got worse due to DBS therapy.
- 50% of the participants whose speech got worse following DBS reported that the worsening of speech following DBS was unexpected.
- Of the participants whose speech improved following the adjustment to DBS settings, 20% reported that other symptoms got worse; thus, there was a trade off for some individuals.
- 94% of the participants indicated that they are satisfied with the outcome of their DBS therapy based on the symptom improvement received from DBS, even in the context of having some side effects.

- Despite speech disturbance following DBS, 97% of the participants reported that DBS has improved their overall quality of life.

DISCUSSION/IMPLICATIONS:

- The vast majority of individuals with PD experience speech difficulties. Since speech difficulties can result in significant challenges when interacting with others and can result in social isolation and reduced quality of life, assessing and treating the various types of speech disturbance at multiple time points during the course of the PD is indicated. Continued understanding about the “patient’s perception” of his or her speech symptoms related to PD is needed.
- Research has found that DBS therapy affects speech in many individuals who receive this intervention. Speech difficulties that may ensue may manifest in isolated speech symptoms and functional communication deficits, thereby adversely impacting socialization and quality of life.
 - Since DBS therapy is known to have an impact on speech/voice, it would be beneficial to delineate clear expectations for such possible outcomes for individuals who are considering DBS therapy.
 - Although some speech symptoms have been commonly found to result from DBS therapy (e.g., slurred speech, decreased initiation of expressive speech), future research is needed to identify the vulnerability of specific speech patterns that may be created or exacerbated by DBS. Such information could help facilitate better education for DBS candidates and possible treatment recommendations.
 - Research investigating the benefits for speech therapy prior to and after DBS is warranted.
- Treatment for speech disturbance in PD (Lee Silverman Voice Treatment; LSVT) has been scientifically proven to help individuals with speech disturbance, but speech therapy appears underutilized and there are not enough clinicians who provide such services. Increasing accessibility to and utilization of speech therapy, even early in the course of PD, may prove to help PD patients with communication skills and help them remain socially engaged for a longer period of time. Further research as to the effectiveness of speech therapy and its relationship to socialization and quality of life is indicated.
- We need more clinicians trained and delivery supported by technology to increase accessibility.
- Some individuals may not have access to or be able to endure the intensity of LSVT, which may deter some individuals from pursuing speech therapy. Anecdotally, engaging in speech therapy in general may indeed prove to be beneficial for some individuals.
- The effectiveness of technology based intervention (e.g., with the use of the LSVT method) is currently being assessed and may indeed result in increasing accessibility to treatment, promoting home practice, augmenting the effects of LSVT that was rendered in a clinic setting, reducing costs, and supporting long-term practice.
- Intensity and practice are key to success of speech treatment.
- Although the time of the day when speech disturbance is most apparent varies for most PD patients, approximately one-third of the participants in this study reported that their speech was the best in the morning and the worst in the evening.
 - Having knowledge and understanding about patterns of speech disturbance during the day has important practical implications.
 - For example, if individuals experience greater levels of speech disturbance in the afternoon and evening, engaging in any activities in the morning or early afternoon may lead to greater participation and satisfaction (e.g., going to appointments, running errands, and engaging in other activities).
 - The converse is also true. Increased assistance and support may be needed during times when speech disturbance is known to be more pronounced (e.g., late afternoon or evening).
 - Such planning, may result in less emotional reactivity (e.g., frustration, sadness, disappointment, etc.) when socializing.

- Future research should explore: (1) whether patients have heard of or been offered any voice treatment from their providers to see if such treatment options are being considered and recommended; (2) availability/ accessibility of voice treatment for individuals with PD; and (3) if voice treatment is indeed being offered, are individuals with PD choosing not to pursue such treatment. Thus, future studies could investigate the frequency of recommendations for/referrals to speech therapy, the accessibility of speech therapy, and the utilization of speech therapy in the PD population.
- **It is important to consider the following point when reading this report:**
 - Although the Voice Handicap Index is a validated instrument, the other questions regarding speech symptoms are not part of a validated instrument; the questions were designed by The Parkinson Alliance to gain a better understanding of speech characteristics and “profiles” as it relates to the patient’s perspective.

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Margaret Tuchman,
Bilateral DBS-STN, 2000
President, The Parkinson Alliance

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