

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

INTRODUCTION

Speech is a complex behavior that is coordinated by an integrated network of sensory, muscular, respiratory, and cognitive systems. As a result of the complex nature of speech, symptoms of speech impairment can be quite diverse, reflecting dysfunction in one or more of these systems. 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 PD.¹ The scientific literature examining speech in PD is vast and the following paragraphs are intended to provide only a brief introduction to this topic as it relates to the current research project.

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, imprecise consonants, and a breathy and harsh voice.^{2,6}
- In other words, the speech impairments can show themselves in PD through impacting vocal sounds, overall expression of words, breath control during speech, speech volume (softening speech volume), and/or changes in intonation or rhythm of speech that reflect emotional expression.^{7,8}

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 production,^{9,13} 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 surgery.
- Some research has found that speech intelligibility (clarity in expressive speech) worsened following DBS, and speech sounded more slurred.^{13,17}
- DBS has also been found to have an adverse impact on intonation or rhythm, articulation, and intelligibility; the stimulation itself can cause changes in speech.^{18,19}
- Speech function is also very susceptible to micro lesions (damage to cellular structures in the brain) due to the surgical procedure itself.^{18,20}
- Krack et al. (2003) examined the long-term outcome of bilateral DBS-STN in 49 PD patients and found that speech functioning declined in these patients after five years.²¹ This result was interpreted as a reflection of the expected decline in speech that one would see in DBS-STN treated patients. According to this study, 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 (2000) conducted a review of the different treatment approaches for persons with PD up to the time of their manuscript and examined the effects of these treatments on speech.⁸ Treatment methods reviewed included speech therapy, pharmacological 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 a few 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 general, LSVT seemingly improves many aspects of speech production. Sharkawi and colleagues (2002) found the LSVT method to help with specific neuromuscular control, which improved vocal intensity as well as tongue function during different phases of swallowing.²²
 - Ramig and colleagues (2004) presented the essential concepts and outcome data for the LSVT, and the research has yielded significant long-term improvement in speech and voice functions in individuals with idiopathic PD.²³

In summary:

- Speech disturbance is a common symptom for individuals with PD.
- More and more research is finding that slurred speech and other aspects of speech are potential side effects of DBS stimulation (if not an exacerbation of a pre-existing speech disturbance).
- In light of much literature on the topic of speech and PD, there continues to be a limited amount of research looking at the patient's perspective of their speech difficulties, and there is indeed a lack of research exploring the differences between individuals with PD with and without DBS.

OBJECTIVE

- To gain further insight in the area of speech in individuals with Parkinson's disease who have and have not undergone Deep Brain Stimulation.

METHODS

- A mail-survey/questionnaire methodology was used. The participants were recruited from a variety of sources. Some had completed previous surveys conducted by The Parkinson Alliance, others responded to study announcements in medical clinics around the country, and still others found out about the study through their participation in local PD support groups, The Parkinson Alliance website (www.parkinsonalliance.org), or our affiliate website devoted to DBS (www.dbs-stn.org). Although 55 percent of the respondents were from the states of New Jersey, New York, Texas, or California, the other respondents represent a broad geographical range, with a total of 32 additional states and 3 countries represented. Each participant was mailed and returned multiple documents including an informed consent form, Voice Handicap Index (VHI²⁴), and a supplemental questionnaire assessing demographics and other clinical characteristics of the sample. The participants in this report included 99 individuals with PD who underwent DBS (of whom 97 had DBS-STN; 85% Bilateral Stimulation) and a comparison group of 150 individuals with PD without DBS.

RESULTS

The summary of the demographic information for this study can be found in Table 1. We collected data from a large, representative group of PD patients spanning a broad range of age and clinical symptoms. The average age of PD onset was 48 for the **DBS** group and 60 for the **Non-DBS** group. Male and female participants were equally represented for each group and most of the patients were married.

Although both groups were closely matched in terms of gender, education, ethnicity, and marital status, there are other important and statistically significant differences between the two groups on a couple of demographic and clinical variables. The PD patients with **DBS** were significantly younger than the **Non-DBS** group. Additionally, the age of PD onset was earlier in the **DBS** group than the **Non-DBS** group.

Duration of PD within the two groups:

One of the most important components of this research project was interpreting the data with the consideration for the differences of disease duration between the two groups. As you will see, there were more recently diagnosed participants in the **Non-DBS** group as compared to the **DBS** group. The opposite was true for those participants who have had PD for longer periods of time (see Figure 1). *Because disease duration likely explains some of the differences between the two groups, all analyses reported took into account disease duration.*

Speech Symptoms:

- We found that the **DBS** group was more likely to experience speech difficulties than the **Non-DBS** group, although it is notable that a significant number of participants in both groups experienced changes in speech (**DBS**=92%; **Non-DBS**=87%; see Table 2).
- The **DBS** group also tended to rate their speech difficulties as “quite a bit” to “extremely” more often than the **Non-DBS** comparison group; suggesting a greater severity of difficulties for the **DBS** group.
- The **DBS** group also reported more problems with other people understanding them than the **Non-DBS** group.
- Although the two groups had some differences from each other in the context of how they perceive their speech difficulty, we want to acknowledge that both groups reported problems with others understanding them (**DBS**: 93%; **Non-DBS**: 67%).
- When compared to the **Non-DBS** group, the **DBS** group reported that they were communicating less often due to their speech difficulties.
- There were no differences between the **DBS** and **Non-DBS** groups as it relates to the time of day that their speech is the best or worst; both groups generally identified that their speech performance was variable across the day.
- The **DBS** group reported more problems than the **Non-DBS** group with slurring, festinating speech (the expression of words that accelerates while talking, and the space between words becomes shorter and shorter), speaking rapidly, initiating speech, and monotone voice (see Table 3).

Speech after DBS:

- Research regarding the non-motor complications of DBS continues to be conducted. Our study showed that 68% of the individuals with DBS that experienced speech difficulties attributed those problems directly to DBS.
- According to the literature, the most commonly seen voice difficulty is slurred speech, which was reported in approximately three-fourths of the participants in this study.
- Of those that experienced slurred speech, about half thought that it was due to DBS. It is notable that with this group, low volume (hypophonia) was the most commonly endorsed voice change.

The Voice Handicap Index:

The Voice Handicap Index (VHI)²⁴ is a common 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. People ask me to repeat myself when speaking face-to-face.

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.

As indicated in Figure 2, all four paired comparisons for the VHI data (the 3 subtests and the total score) revealed statistically significant differences between the **DBS** group and the **Non-DBS** group.

- For each subsection of the VHI the average rating of speech disturbance for each group revealed:
 - **DBS** participants had a higher rating of interference on "functional" aspects of communication than the **Non-DBS** group.
 - **DBS** participants had a higher rating of interference on the "physical" aspects of verbal expression than the **Non-DBS** group.
 - **DBS** participants had a higher rating of voice disturbance that adversely affects their emotional well-being than the **Non-DBS** group.
 - **DBS** had a "Total" index score that was higher than the **Non-DBS** group, indicating that individuals with **DBS** reported higher ratings of "voice disturbance" that interferes with aspects of their daily life as compared to the **Non-DBS** group.
- Thus, the **DBS** group had higher ratings of voice disturbance that interfered with their daily life, and they reported having a greater adverse emotional response to their voice difficulty.

Treatment for speech difficulties:

- With the vast majority of PWP experiencing speech difficulties (87% **Non-DBS**; 92% **DBS**), it was surprising that very few individuals underwent any voice treatment (see Table 4).
- We found that significantly more participants from the **DBS** group underwent either the Lee Silverman Voice Treatment (LSVT) or other voice treatment than the **Non-DBS** group.

- LSVT uses voice training techniques that are intended to help patients with PD increase intelligibility and vocal loudness. For those undergoing LSVT, there was no significant difference between groups as it relates to its perceived benefit, but both groups acknowledged experiencing at least some improvement with this therapy.
- Of those that underwent either the LSVT or other voice treatment almost all of the participants from both groups found at least some benefit from such treatment, suggesting that this line of therapy may benefit others with PD (See Table 4).

DISCUSSION

- This research project underscores the prevalence of speech disturbance in the PD community. A vast majority of the participants in both groups perceived changes in speech (**DBS=92%**; **Non-DBS=87%**), reflecting the importance of further research in this area and the need for improved intervention.
- Although both the **DBS** and **Non-DBS** groups reported significant difficulties with speech, the **DBS** group reported more severe speech disruption and related problems than the **Non-DBS** group.
- In fact, the result from the Voice Handicap Index (VHI) revealed that the **DBS** group had reported greater negative effects of voice disturbance on their daily life (from having physical difficulties to functional limitations of communication), and that they have a greater adverse emotional response to their voice difficulty than the **Non-DBS** group.
- It is notable that almost 70% of participants that underwent **DBS** were not aware that one adverse side effect from this treatment is slurred speech. It is also notable that 85% of those experiencing speech changes indicated that they would go through with the surgery again even knowing that slurred speed or other speech disturbance was likely. It is important to raise awareness of such possible non-motor adverse events from this treatment option so that PWP can be informed consumers before making a decision about their treatment.
- Treatment options for voice difficulties related to PD as well as to DBS need to be further evaluated. As seen in our data, not many of the participants had undergone such therapy, and for those who engaged in the treatments for their speech disturbance, the majority of each group reported having at least a modest success rate.
- One could deduce that better treatment accessibility and/or utilization needs to occur as such a great number of individuals with PWP are affected by speech difficulties. It appears that there is limited accessibility and inconsistent/infrequent utilization of speech therapy. There are studies that have looked at mechanical measurement of speech (e.g. pauses taken, decibel change, etc.) and found mixed findings about the relationship of PD and speech difficulties. However, speech difficulties are known to exist in this population, and the patient's perception of his/her speech should not be overlooked or minimized as compared to the scientific "mechanical measurements" of speech.
- It is very important to monitor how the PWP and his/her family perceive his/her speech, as it will affect their everyday lives and general quality of life. Moreover, speech difficulties can have a devastating impact on both general communication with others, and socialization and quality of life can be significantly reduced due to speech disturbance. Further investigation pertaining to the "patient's perception" of their speech symptoms of PD as well as how it is affected by DBS is warranted.
- It would have been interesting to ask participants if they had heard of or been offered any voice treatment from their providers to see if such treatment options are being considered or are available to most PWP versus if it is being offered and PWP are not choosing that line of treatment. Thus, future studies could investigate the frequency of recommendations for speech therapy, the accessibility of speech therapy, and the utilization of speech therapy in the PD population.

- In summary, the evolutionary aspects of studying speech disruption in PD have led to tremendous advances in the understanding of speech disturbance in PD, and there have been several investigations examining the effect of DBS-STN on speech functions. Although some research has found speech to be improved by bilateral DBS-STN,^{11,25} the majority of research has suggested that the increase of impaired speech appears to be an underestimated problem in this population.^{9,20,18,19,26,27} There is convincing evidence that STN stimulation can have either no impact on the natural progression of speech problems in PD, or, and more commonly seen, it may have a harmful effect on speech. Thus, continued research pertaining to the patient's experience with and perspective on speech disturbance and its impact on quality of life is indicated.

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Margaret Tuchman
President
The Parkinson Alliance

References

* A detailed list of references can be found on the report posted on our website. Please visit DBS-STN.org.

Table 1. Demographics and clinical features of the sample

Variable	Non-DBS	DBS
Mean Age in years *	68	63
Duration of PD in years *	8.0	15.8
Percent Male	61%	57%
Percent Female	39%	43%
Percent Married	77%	64%
Mean Age of PD onset (in years)*	60	47
Average Time since DBS-STN (in years)	n/a	4.4

* denotes significant differences between the groups

Figure 1. Disease Duration Categories (in Years) for DBS (N=99) and Non-DBS Groups (N=150)

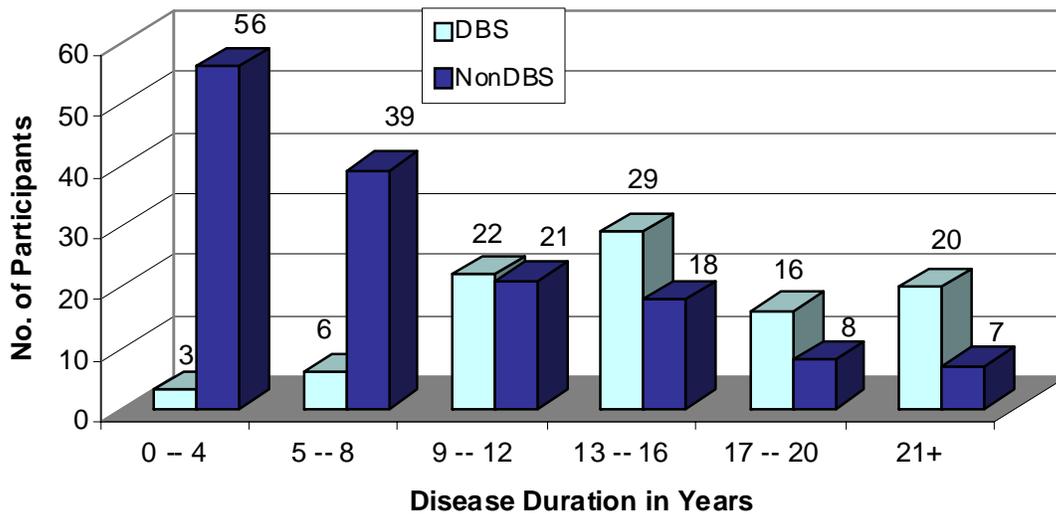


Table 2. General questions about speech: Differences between DBS and Non-DBS participants

Questions related to speech	Non-DBS (n=150)	DBS (n=99)
* Have you experienced speech difficulties since you have been diagnosed with PD?		
No Problems	13%	8%
A little Bit	40%	18%
Moderately	26%	27%
Quite a Bit/Extremely	21%	47%
* How would you rate your overall speech problems?		
No Problems	17%	6%
A little Bit	36%	13%
Moderately	30%	28%
Quite a Bit	17%	53%
* To what extent do you think other people can understand you?		
No Difficulty	24%	7%
A little bit of difficulty	41%	24%
Moderate difficulty	26%	29%
Quite a bit/Extreme difficulty	9%	40%
At what time of day is your speech the best?		
Morning	32% (n=119)	39% (n=93)
Afternoon	10%	8%
Night	3%	2%
Variable	55%	51%
At what time of day is your speech the worst?		
Morning	10% (n=118)	10% (n=93)
Afternoon	9%	8%
Night	31%	31%
Variable	50%	52%
*Are you communicating Less?		
No	40%	13%
A little Bit	29%	24%
Moderately	17%	25%
Quite a Bit/Extremely	14%	38%

* denotes significant difference

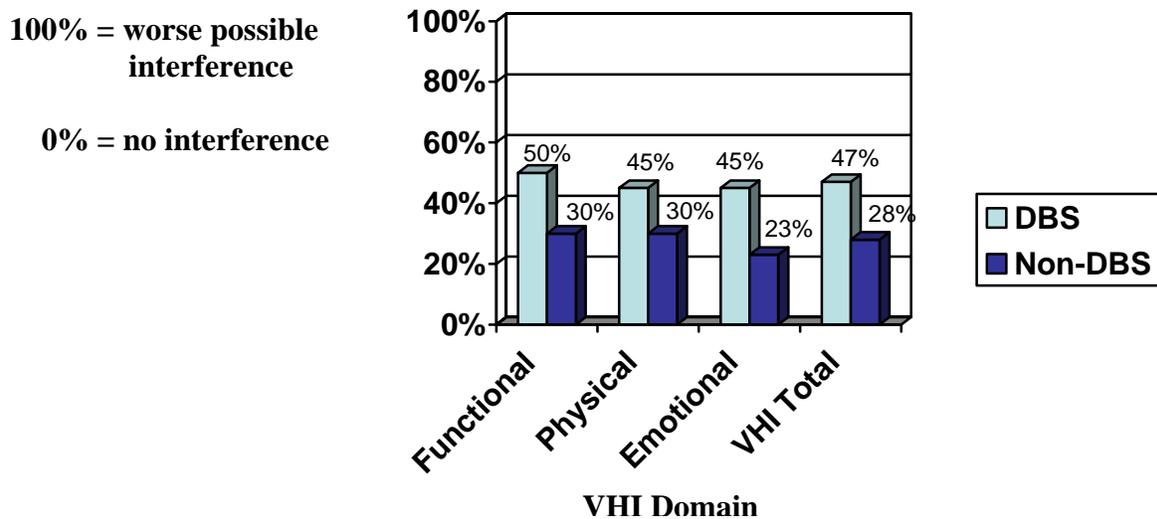
Table 3. Types of Speech Difficulties Experienced: Differences between DBS and Non-DBS participants

Questions related to speech	Non-DBS (n=150)	DBS (n=99)
*Slurred Speech	40%	76%
Low Volume	79%	84%
Hoarseness in Speech	44%	39%
*Festinating Speech**	21%	33%
*Rapid Speech	16%	28%
Tremulous Speech	17%	15%
*Difficulty Starting Speech	27%	44%
* Monotone Speech	29%	44%
Stuttering	17%	23%
Swallowing	34%	44%
Word Finding Difficulties	53%	57%

* denotes significant difference

** Festinating speech is the expression of words that accelerates while talking

Figure 2. Voice Handicap Index (VHI): Average percentage of voice interference for DBS (n=99) and Non DBS (n=150) participants



*There was a statistically significant difference between groups in each domain

Table 4. Voice Treatment for Speech Difficulties: Differences between DBS and Non-DBS participants

	Non-DBS	DBS
*Have you undergone LSVT? (YES)	14% (n=150)	26% (n=99)
*Have you undergone other voice treatment?	13%	28%
Was LSVT helpful?		
Not Helpful	0% (n=21)	14% (n=28)
A little Bit	19%	21%
Moderately	33%	36%
Quite a Bit	29%	25%
Extremely	19%	4%
Was other voice treatment helpful?		
Not Helpful	0% (n=19)	18% (n=28)
A little Bit	58%	32%
Moderately	26%	39%
Quite a Bit	11%	11%
Extremely	5%	0%

* denotes significant difference

LSVT= Lee Silverman's Voice Treatment

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