

Speech following DBS in Parkinson's Disease Articulation and Phonetics



Fabian Klostermann

Charité – University Medicine Berlin
Dept. of Neurology
Motor and Cognition Group

Aix-en-Provence

Background

Clinical situation

- Most PD patients develop speech disorders in the course of the disease.
- This problem benefits less from subthalamic DBS than PD motor signs and partly even worsens under this therapy.  

Aim

- To assess levels of speech affected by DBS / net effects.

Study / Participants

Perceptual / technical speech analysis in PD patients off vs. on STN DBS

- 20 PD patients (age 66±9 / PD duration 16,6±7 / 700±350 mg levodopa equivalent)
- DBS of STN for 2,6±1,4 years
- no dementia or depression (MMSE ≥ 24, BDI ≤ 15)
- no dysarthria unrelated to PD
- native German Speakers
- right-handed
- stable therapeutic setting of DBS parameters

Parameters of subthalamic DBS

	Left hemishpere	Right hemishpere
Stimulation		
Monopolar		
Active electrode		
0	5	5
1	18	14
2	5	6
3	0	1
1 negative contact	10	12
2 negative contacts	9	7
Electrical settings		
Amplitude (V)	3.15 (0.89)	2.78 (0.97)
Pulse width (µs)	84 (21)	85 (21)
Frequency (Hz)	138 (13)	138 (13)
Position contact 1		
Laterality (from AC-PC)	11.7 (1)	11.9 (0.7)
Posteriority (to MCP)	-2.4 (2)	-2.5 (2.2)
Verticality (from AC-PC)	-3.2 (1.7)	-2.7 (1.7)

AC-PC, anterior and posterior commissure; DBS, deep brain stimulation; MCP, mid-commissural point; STN, subthalamic nucleus.

Exams of Speech

Perceptual analysis

- UPDRS, Item 5 (self-evaluation)
- UPDRS, item 18 (physician's evaluation)
- blinded speech rating by speech therapist (Darley / Aronson / Brown)
- auditory speech analysis (ASA, blinded rating of 29 voice and speech items in face-to-face interview by speech therapist)

Technical analysis

- perturbation measures
- voice field
- electroglottography
- laryngeal videostroboscopy
- oral diadochokinesis
- maximum phonation time
- speech velocity

Exams of Speech

Perceptual analysis

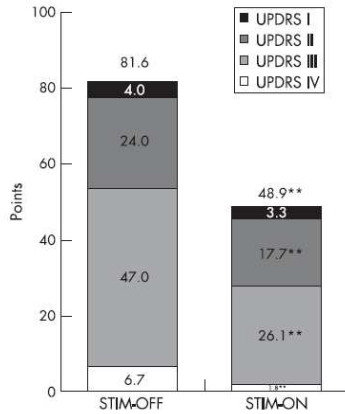
- UPDRS, Item 5 (self-evaluation)
- UPDRS, item 18 (physician's evaluation)
- blinded speech rating by speech therapist (Darley / Aronson / Brown)
- auditory speech analysis (ASA, blinded rating of 29 voice and speech items in face-to-face interview by speech therapist)

Technical analysis

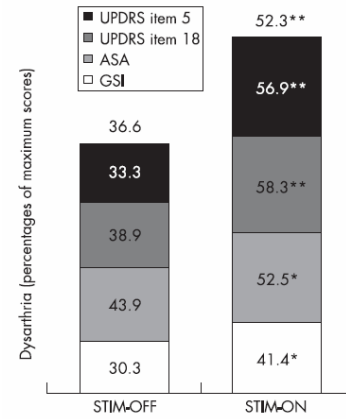
- perturbation measures
- voice field
- electroglottography
- laryngeal videostroboscopy
- oral diadochokinesis
- maximum phonation time
- speech velocity

Overall Results

motor improvement under DBS



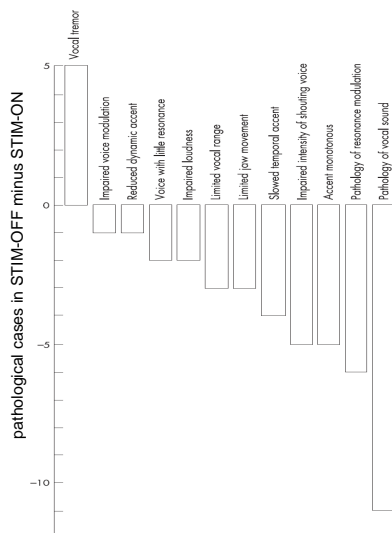
...with perceived speech worsening



statistical difference of respective test-scores in STIM-ON vs. STIM-OFF: * ~ p<.05 / ** ~ p<.01

Perceptual Speech Measures

Auditory Speech Analysis



UPDRS Speech Rating

5. Speech

0 = Normal

1 = Mildly affected, no difficulty being understood

2 = Moderately affected, sometimes asked to repeat statements

3 = Severely affected, frequently asked to repeat statements

4 = Unintelligible most of the time

18. Speech

0 = Normal

1 = Slight loss of expression, diction and/or volume

2 = Monotone, slurred but understandable; moderately impaired

3 = Marked impairment, difficult to understand

4 = Unintelligible

Coherence of Perceptual Speech Measures

Correlation of Perceptual Rating Methods

STIM-OFF	ASA	UPDRS 5	UPDRS 18	GSI
ASA	1	0.389	0.580(**)	0.485(*)
UPDRS 5		1	0.739(**)	0.377
UPDRS 18			1	0.353
GSI				1

STIM-ON	ASA	UPDRS 5	UPDRS 18	GSI
ASA	1	0.509(*)	0.342	0.578(*)
UPDRS 5		1	0.840(**)	0.495(*)
UPDRS 18			1	0.412
GSI				1

...highest correlation between simple self-evaluation and physician's rating of speech.

Technical Analyses

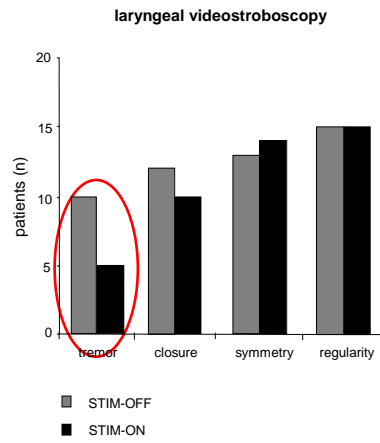
Computerized Analysis of Sustained Vowel / Voice Range Profile

Parameter	STIM-OFF	STIM-ON
CASV (threshold values in parentheses)		
Fo (Hz)	153.5 (+/-35.5)	149.1 (+/-31.6)
Jitter (%)	2.4 (+/-1.4)	3.8 (+/-3.4)
Shim (%)	8.3 (+/-4)	7.7 (+/-2.7)
NHR (n/h)	0.2 (+/-0.03)	0.2 (+/-0.1)
VPR		
<i>Frequency range (HT)</i>		
Speaking voice	14.3 (+/-5.3)	13.8 (+/-6.4)
Singing voice	18.2 (+/-8.7)	16.2 (+/-7.4)
<i>Amplitude range (dB)</i>		
Speaking voice	34.1 (+/-7.3)	30.7 (+/-9.4)

Whether in STIM-OFF or STIM-ON, CASV results were beyond normal values.

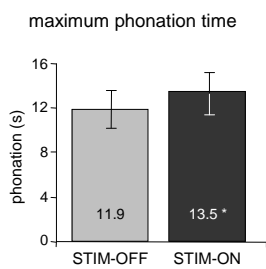
No significant changes occurred as a function of the stimulation state.

Technical Analyses



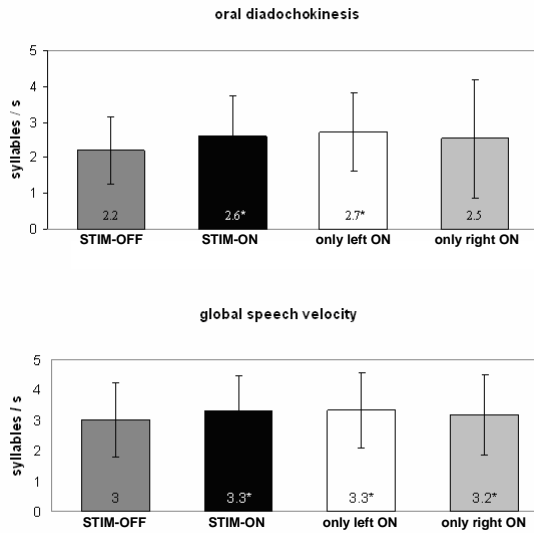
*DBS-induced reduction of glottic **tremor**.*

Technical Analyses



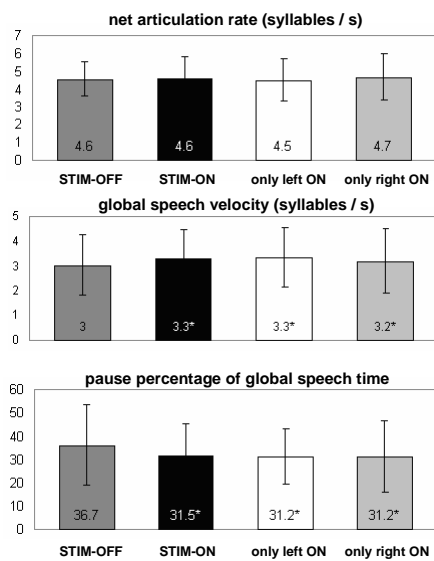
*DBS-induced increase in phonation time might be due to a reduction of **rigidity**, improving respiratory function.*

Technical Analyses



*DBS-induced increase in speech velocity is compatible with the reduction of **bradykinesia** in PD.*

Technical Analyses



The velocity of utterances remains invariant between STIM-OFF and STIM-ON.

*DBS acceleration of speech appears first of all to rely on a reduction of pause time, i. e. on **changed speech sequencing**.*

Discrepancy of Technical and Perceptual Findings

PD speech modulation by

•antibradykinetic

•tonolytic



without beneficial effect

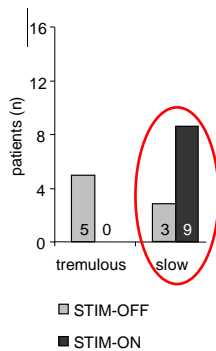
•tremorolytic

of subthalamic DBS.

Possible Explanation: I

Antiparkinsonian actions of subthalamic DBS, beneficial for body movements, do not necessarily go along with perceived improvement of speech.

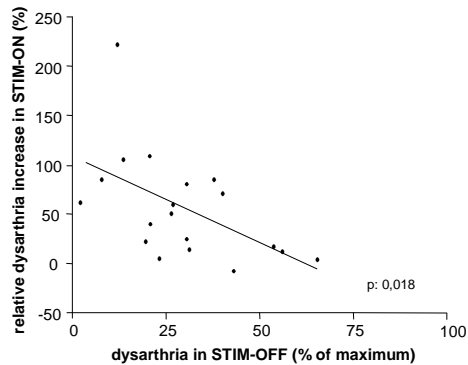
Example of Speech Therapist's Ratings



Whereas voice tremor was perceived as technically assessed, perception of speech velocity was contrary to technical evidence.

Possible Explanation: II

PD-independent detrimental effects outweigh overall improvement of PD-specific speech impairment.



Individually, slightly dysarthrophonic PD patients have a relatively high increase of speech impairment under DBS, and vice versa.

This points to a stable dysarthrogenic factor, facilitated by DBS.

Together with the absence of relation to electrode coordinates, this might be indicative of a role of proper STN stimulation in speech dysfunction.

Conclusions

Subthalamic DBS counteracts PD-speech changes, effectuated on the level of the motor disorder.

These effects are not necessarily positive on the level of speech, eventually due to discrepancies between evaluation systems for body versus ‚linguistic‘ movements.

Besides, a relatively stable, PD-independent DBS effect appears to hamper speech performance.

Particularly, changed sequencing might perceptually result in inarticulate and prosodically abnormal speech.

Disturbed speech sequencing could arise from DBS actions within STN proper.

Thank you very much!