Functional neuroimaging of Parkinson's disease speech: motor aspects

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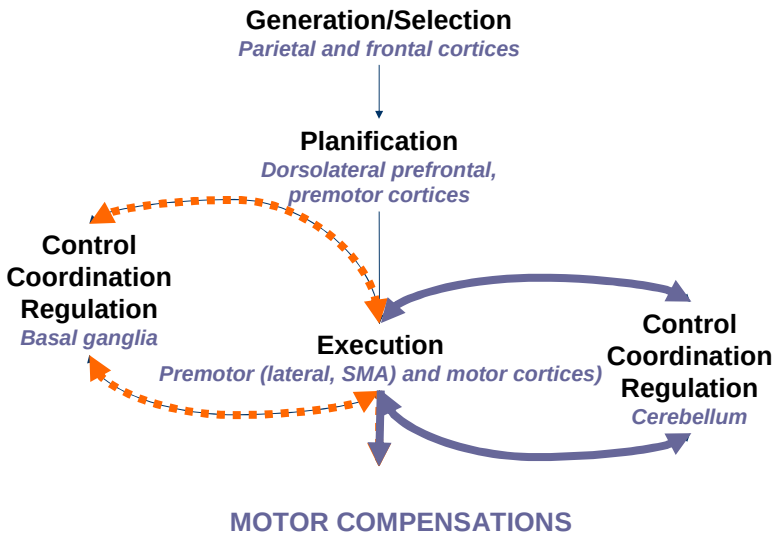

Hypophonia in Parkinson's disease

Neural correlates of voice treatment revealed by PET

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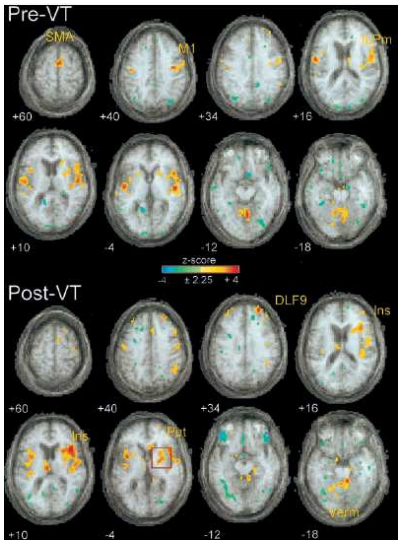
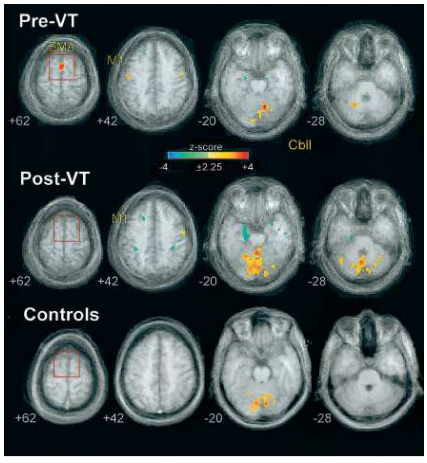
From the Research Imaging Center (Drs. Liotti and Fox, C.I. Cook) and the Departments of Medicine (Neurology) (Drs. Liotti, Vogel, New, and Fox) and Radiology (Drs. Liotti and Fox), University of Texas Health Science Center at San Antonio; The Department of Speech, Language and Hearing Science (Dr. Ramig), University of Colorado at Boulder; The Wilbur James Gould Voice Center (Dr. Ramig), Denver, CO; The Department of Speech Communication Disorders (Dr. Vogel), Our Lady of the Lake University, San Antonio, TX; and The Department of Speech and Hearing Sciences (Drs. R.J. Ingham and J.C. Ingham), University of California, Santa Barbara.

Neurology
2003, 60: 432–440

PET
5 patients, data on L-dopa, pre-voice treatment
Compared to controls and post-voice treatment
- phonation (vowel /a/)
- paragraph reading





Before VT, patients had strong speech-related activations in motor and premotor cortex (M1-mouth, supplementary motor cortex [SMA], and inferior lateral premotor cortex [ILPm]), which were significantly reduced post-VT

PAROLE ET LANGAGE

Subthalamic nucleus stimulation and dysarthria in Parkinson's disease: a PET study

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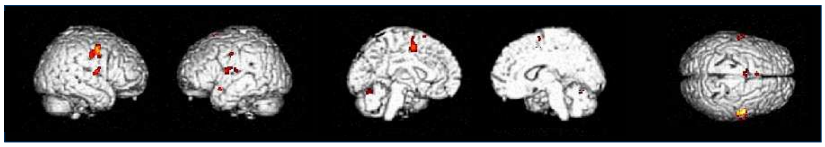
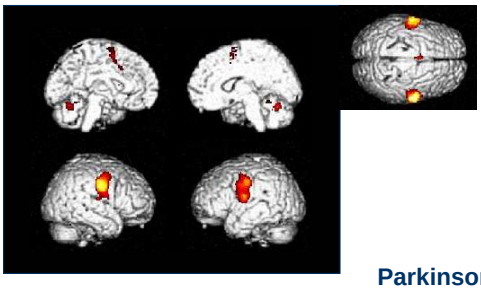
Brain
2004, 127: 602-615

PET
10 patients, data off STN stimulation, off L-dopa
Compared to on stimulation and controls
- repetition of 1 sentence
- silent articulation

PAROLE ET LANGAGE





Parkinsonian dysarthria is associated with altered recruitment of the main motor cerebral regions (orofacial M1, cerebellum), and increased involvement of the premotor and prefrontal cortices (DLPFC, SMA, superior premotor cortex)

PAROLE ET LANGAGE

Functional Abnormalities in the Primary Orofacial Sensorimotor Cortex During Speech in Parkinson's Disease

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Movement Disorders
2007, 22(14): 2043–2051

fMRI
9 patients, data on L-dopa
Compared to controls
- production of 40 sentences

PAROLE ET LANGAGE

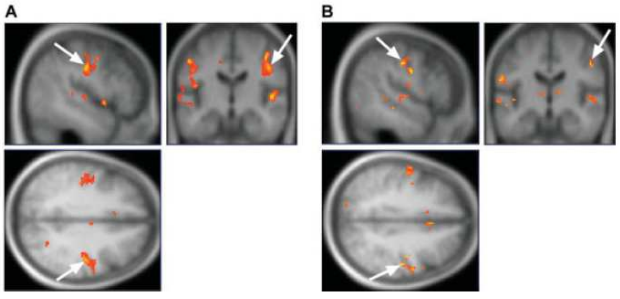

FIG. 1. BOLD signal increases in the right primary sensorimotor cortex (white arrow) during overt reading in PD patients (A) and controls (B); MNI coordinates for peak voxel values: 46, −14, 36 and 50, −14, 40 for patients and controls, respectively; significance threshold $P < 0.001$ uncorrected.

In PD patients, as compared with controls, we found significantly higher BOLD signal in the right primary orofacial sensorimotor cortex and more robust correlations between the measured speech parameters and the BOLD response to reading, particularly, in the left primary orofacial sensorimotor cortex

PAROLE ET LANGAGE

Functional mapping in PD and PSP for sustained phonation and phoneme tasks☆

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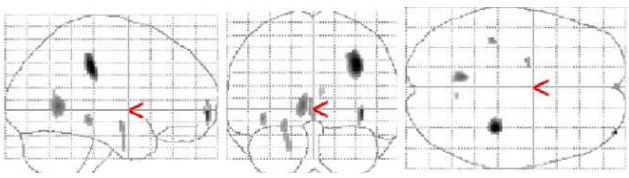
Journal of the Neurological Sciences
2008, 273: 51-56

fMRI
21 patients, data off L-dopa
Compared to controls
- phonation (vowel /a/)
- /pa/, /ta/, /ka/ repetition

Basal Ganglia Speech Disorders and Deep Brain Stimulation – 2nd International Symposium
2010, Aix-en-Provence, France

PAROLE ET LANGAGE



Reduced and	increased activation
Sup occ lobe (L)	Mid occ gyrus (L)
Mid temp gyrus (L/R)	Mid temp gyrus (L)
Sup temp gyrus (L)	Precuneus (L)
Cuneus (L)	

A Non-Invasive Imaging Approach to Understanding Speech Changes following Deep Brain Stimulation in Parkinson's Disease

Shalini Narayana, Ph.D.[1], Adam Jacks, Ph.D.[1], Donald A. Robin, Ph.D.[1,2,3], Howard Poizner, Ph.D.[4], Wei Zhang, Ph.D.[1], Crystal Franklin, B.S.[1], Mario Liotti, M.D., Ph.D.[5], Deanie Vogel, Ph.D.[6], and Peter T. Fox, M.D.[1,7]

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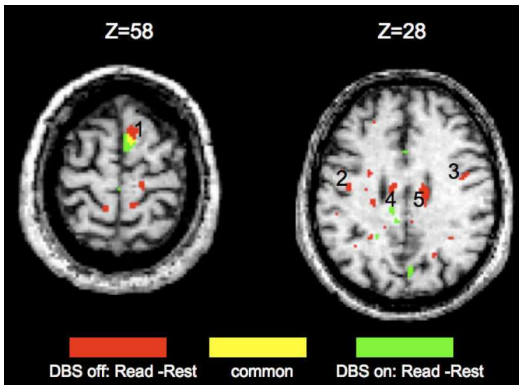
American Journal of Speech and Language Pathology
2009, 18(2): 146–161

PET
1 patient, data off STN stimulation and on L-dopa
Compared to on stimulation
- phonation (vowel /a/)
- paragraph reading

Basal Ganglia Speech Disorders and Deep Brain Stimulation – 2nd International Symposium
2010, Aix-en-Provence, France



1. SMA
2. Left M1 mouth
3. Right M1 mouth
4. Left cingulate cortex
5. Right cingulate cortex

Speech production was perceptually inferior and acoustically less contrastive during left STN stimulation compared to no stimulation. Increased neural activity in left dorsal premotor cortex (PMd) was observed during DBS on.

Neural Correlates of Efficacy of Voice Therapy in Parkinson's Disease Identified by Performance–Correlation Analysis

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Human Brain Mapping
2010, 31: 222–236

PET
10 patients, data on L-dopa, post-voice treatment
Compared with pre-voice treatment
- paragraph reading

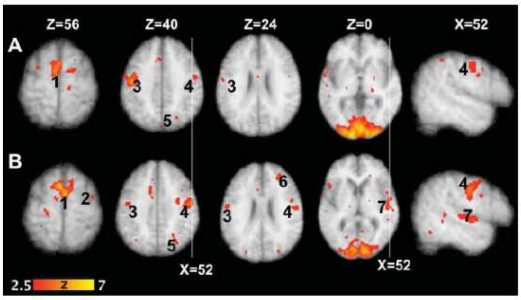


Figure 2.
Activation pattern during paragraph reading in individuals with IPD hypophonia. Top panel **A:** Pre LSVT LOUD and bottom panel **B:** Post-LSVT LOUD. (1) Bilateral SMA, (2) right PMd, (3) left primary motor cortex (M1-mouth), (4) right primary motor cortex (M1-mouth), (5) right parietal cortex (BA 7), (6) right dorsolateral prefrontal cortex (BA 9), and (7) right superior temporal cortex. The figures in the last column are coronal sections (at $x = 52$) show increased right M1 activation, as well as appearance of right superior temporal gyrus activation post-LSVT LOUD during a speech task.

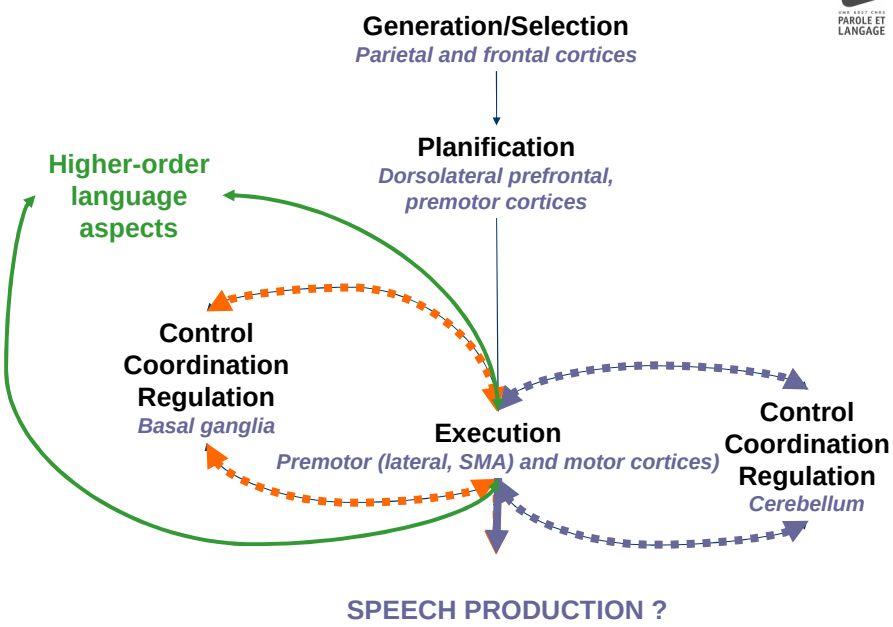
Neuronal activity during reading in the pre- versus post-LSVT LOUD contrast was correlated with corresponding change in vocal intensity to generate correlation images. Behaviorally, vocal intensity for speech tasks increased significantly after LSVT LOUD. The contrast and correlation analyses indicate a treatment-dependent shift to the right hemisphere with modification in the speech motor regions as well as in prefrontal and temporal areas. We interpret the modification of activity in these regions to be a top–down effect of LSVT LOUD.

Reduced and	increased activation	compared to controls and/or treatment	*Methodological issues*
Cereb (L/R)	PM/M1 cortex (L/R) SMA	**Liotti *et al.*, 2003 (PET)** (5 patients, data on L-dopa, pre-voice treatment, compared to controls and post-voice treatment) - phonation (vowel /a/) - paragraph reading	5 patients Patients on-dopa
Orofacial M1 (R) Inf temp gyrus (R) Postcent gyrus (R) *Cereb (L/R)*	SMA (L) DLPFC (L/R)	**Pinto *et al.*, 2004 (PET)** (10 patients, data off STN stimulation, off L-dopa, compared to controls and on stimulation) - repetition of 1 sentence - silent articulation	One sentence only M1 activation decrease only in silent articulation
SMA	SM cortex (R)	**Rektorova *et al.*, 2007 (fMRI)** (9 patients, data on L-dopa, compared to controls) - production of 40 sentences	Patients on-dopa Cereb excluded from fMRI analyses
Sup occ lobe (L) Mid temp gyrus (L/R) Sup temp gyrus (L) Cuneus (L)	Mid occ gyrus (L) Mid temp gyrus (L) Precuneus (L)	**Sachin *et al.*, 2008 (fMRI)** (21 patients, data off L-dopa, compared to controls) - phonation (vowel /a/) - /pa/, /ta/, /ka/ repetition	Sustained phonation and phoneme task only
Hand M1 (L) SMA	STN, thal, GPe (L) Put (R/L) Dorsal PM (L) Front eye field (L) DLPFC (L) Ant cing cortex (L/R) Inf front cortex (L/R)	**Narayana *et al.*, 2009 (PET)** (1 patient, data off STN stimulation, on L-dopa, compared to on stimulation) - phonation (vowel /a/) - paragraph reading	One patient only Patient on-dopa No control group No off-on contrast
Globus pallidus (L)	DLPFC (R) Dorsal PM (R) Temp cortex (R) M1 (R) SMA (L)	**Narayana *et al.*, 2010 (PET)** (10 patients, data on L-dopa, post-voice treatment compared with pre-voice treatment) - paragraph reading	Patients on-dopa No control group and pre/post treatment contrast

SMA and premotor cortex

M1 cortex

Cerebellum



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Longitudinal cerebral blood flow changes during speech in hereditary ataxia

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