# Improving fMRI in Parkinson's Disease by Accounting for Realistic Motor Output

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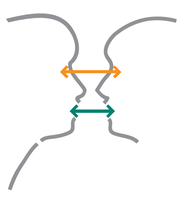


## Introduction

In Parkinson's disease (PD), the motor loop functioning and the patients' motor output are unpredictable, due to brain compensatory mechanisms initiated up to decades before diagnosis.[1]

Consequently, the accuracy of motor tasks during fMRI is impeded, and deviations of the movement performance affect results.

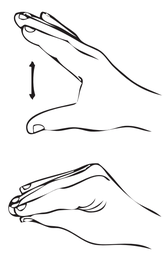
Kinematic modeling based on simultaneous measurements with MR-compatible gloves has been previously proposed as means to address this problem[2] and outperform conventional boxcar modeling (Standard).

Here, we adopted this approach in a larger cohort along with conservative statistics employing family-wise error (FWE) correction at the voxel level ($p < 0.05$) to be less prone to produce false positives.

## Methods

500 s: 25 x 10s (Tapping) + 25 x 10s (Rest)

n = 31*
- 1st Session — L-Dopa
- 2nd Session 1 h after L-Dopa 250 mg/25 mg carbidopa



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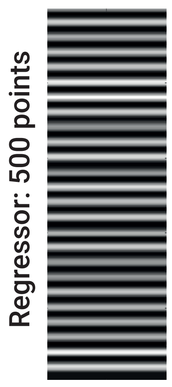
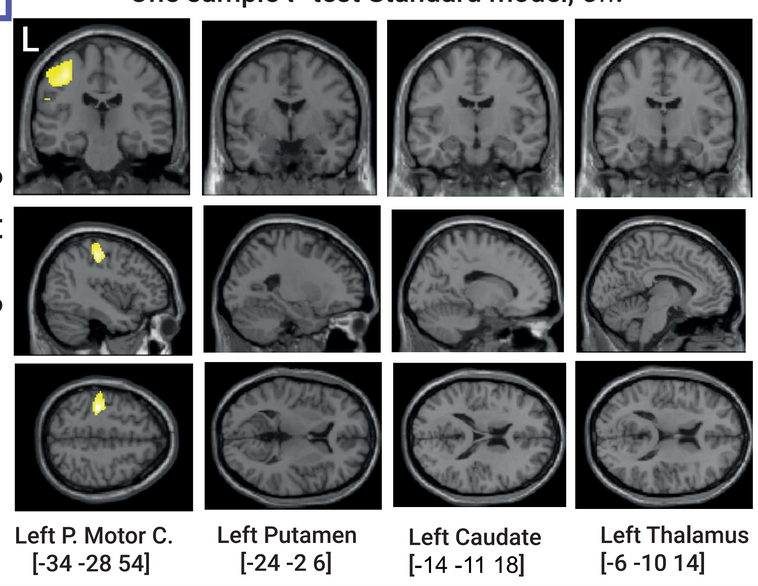



- MRI: 1.5-T MAGNETOM Symphony scanner (Siemens, Germany) using a birdcage head coil and T2*-weighted gradient-echo echo-planar imaging (EPI) (repetition time, TR=1 s; echo time, TE=54 ms, 500 repetitions).
- Ten oblique slices (thickness 3 mm; 1 mm slice gap; nominal in-plane resolution 3×3 mm²) acquired along central sulcus, covering primary sensorimotor cortex and basal ganglia.
- SPM12 first-level statistics was performed for every session separately using a GLM and glove regressor.
- For all patients and all sessions, both resulting parameter images were fed into an SPM second-level analysis using a flexible factorial design including 3 factors: SUBJECT, OFF/ON, and LEFT/RIGHT.

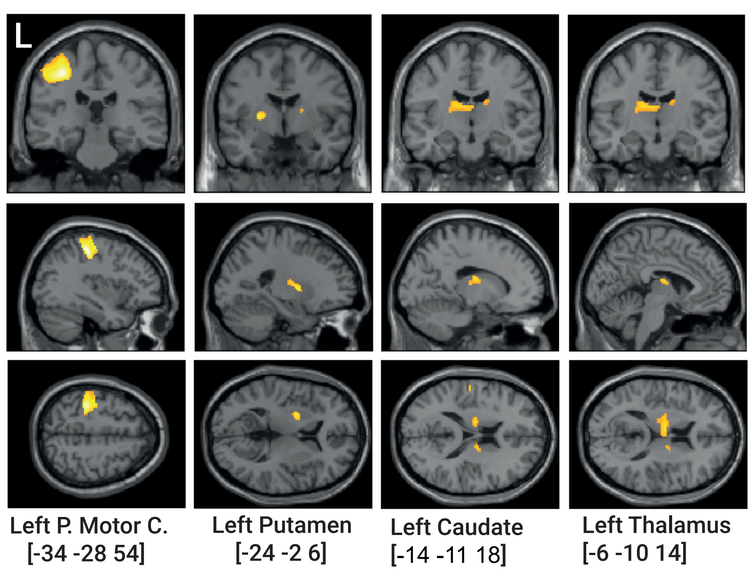
(*) 31 PD patients: equivalent akinetic/rigid type, Hoehn-Yahr stages II-III, 26 males, age 56.1±7.7 y, disease duration 12.2±2.5 y, levodopa treatment duration 9.0±3.0 y.

## Results

**1** One sample *t*- test Standard model, *On*.

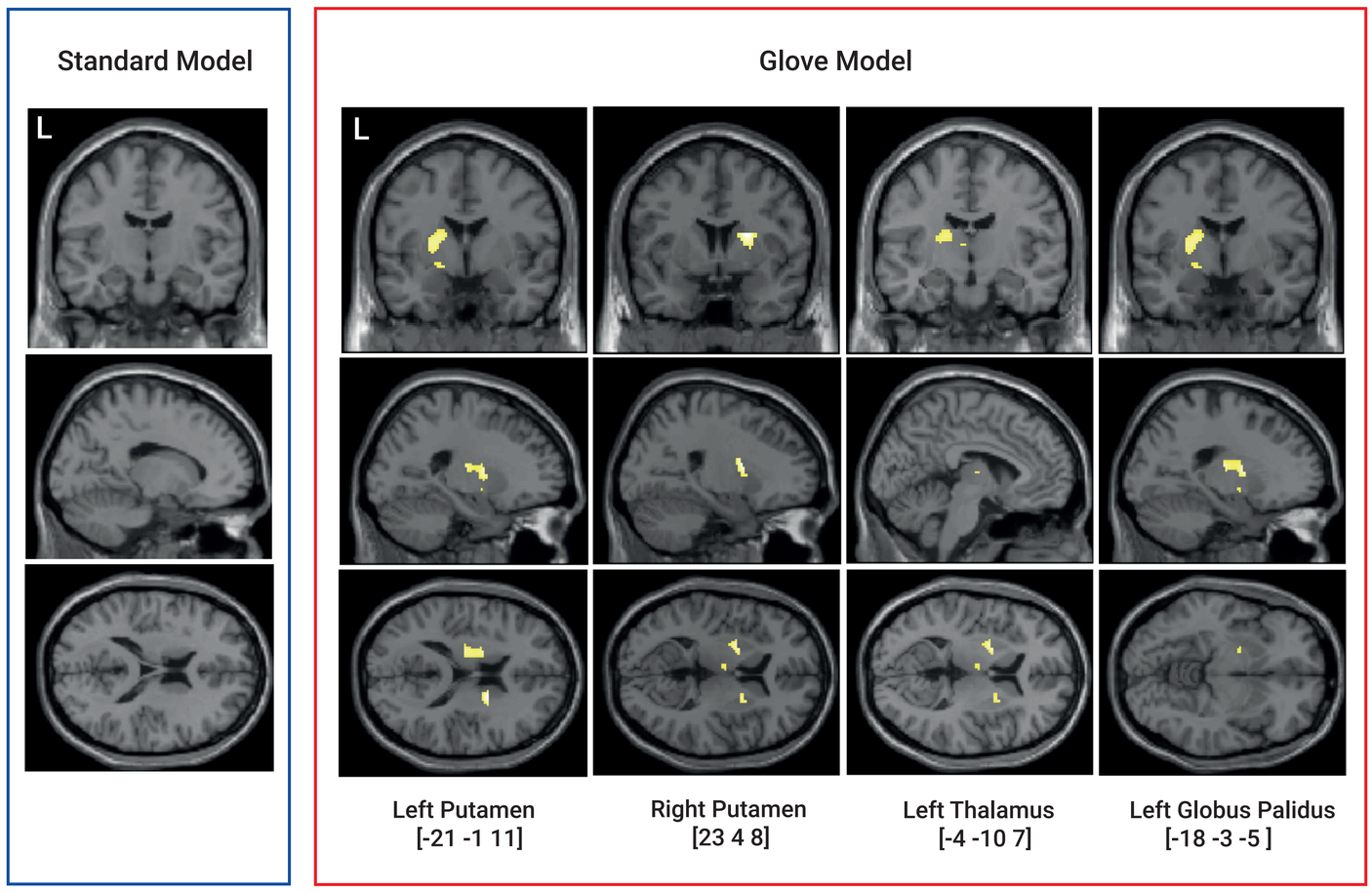



One sample *t*- test Glove model, *On*.




Height threshold $T = 4.24$ { $p < 0.05$ (FWE) at voxel level}

**2** Flexible factorial design *On-Off* contrast




Height threshold $T = 4.03$ { $p < 0.05$ (FWE) at voxel level}

SPM second level analysis from 31 PD patients.
**Left Down red**, *On* patients with ***Glove*** model's One sample t-test during right hand tapping revealed primary motor cortex (1st column) and basal ganglia involved in the motor loop (columns 2-4).
**Left Up blue** *On* patients with ***Standard*** model's One sample t-test revealed solely the primary motor cortex (1st column) and no other voxel survived. Columns 2-4 here depict coordinates where basal ganglia were observed with Glove model.
**Right red**, a flexible factorial analysis where Glove model condition *On* is subtracted from *Off* revealed basal ganglia activity.
**Right blue**, no voxels survived the same flexible factorial analysis with Standard model.

## Discussion

- Our observation that sub-cortical structures like putamen, GP and thalamus emerge in brain imaging by use of the glove device leads us to interpret that the latter succeeds in better representing specific basal ganglia activations producing movement output.
- Implicating the activation of posterior putamen and GP with the L-dopa intake, by means of the On–Off computation, corroborates previous literature[4 5 6 8] suggesting that the posterior putamen is typically the deteriorated structure that leads to PD.
- In the Off state, there is a lack of dopaminergic activation of putamen and GP[8] , whereas dopamine is delivered to the striatum due to L-dopa intake in the On state. The emergence of these nuclei is, hence, expected in response to a motor task as the neurotransmitter binds to the striatum's D1 and D2 receptors.[7]
- Modeling the fMRI signal with the glove regressor resulted in substantial sensitivity improvement as compared to the standard model in line with previous work.

### References

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