Brain Activation in Parkinson's Disease during a Functional Magnetic Resonance Imaging Set Shifting Task: Preliminary Findings
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Objective
To investigate differences in the functional brain patterns for set shifting in patients with Parkinson's disease (PD) and age-matched controls using event-related functional magnetic resonance imaging (fMRI).

Introduction
Cognitive impairment is a common non-motor manifestation of Parkinson's disease (PD). Cognitive deficits include difficulties in set shifting, monitoring behavior and manipulating information and can lead to a significant reduction in quality of life for patients and caregivers.

Functional magnetic resonance imaging (fMRI) is an established method to probe brain activity during task performance of subjects inside a magnetic resonance scanner. Temporal signal variations originating from changes of blood flow to the area of neural activation are analyzed to identify regions in the brain activated during this task. Intergroup comparison can be performed by transforming the activation maps into a standard space (Talairach space) in combination with ANOVA analysis.

Methods

1. Subjects
6 PD patients and 6 healthy controls (HC)

<table>
<thead>
<tr>
<th>Table 1: Demographics</th>
<th>PD</th>
<th>HC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>67/33</td>
<td>50/50</td>
</tr>
<tr>
<td>Age</td>
<td>67.5 (4.3)</td>
<td>62.7 (7.2)</td>
</tr>
<tr>
<td>Education</td>
<td>12.8 (2.9)</td>
<td>15.7 (2.3)</td>
</tr>
<tr>
<td>H&amp;Y off</td>
<td>2.0 to 3.0</td>
<td>NA</td>
</tr>
</tbody>
</table>

2. fMRI Task
In a visual stimulus, large numbers 1-2 composed of small numbers 3-9 were presented and subjects were asked to switch back and forth between sets by responding to the large number or to the small number. The paradigm was presented visually and contained a total of 256 stimuli with 50 switches occurring randomly. Consecutive axial gradient EPI images (256 phases, 64x64,FOV=220mm, slice thickness 3 mm, duration: 12 min 48 sec) were acquired during task performance. Total number of images for this task was in the order of 12,000.

3. Data Analysis
Within the software package AFNI (NIH) the voxel-based timeseries correlated with an ideal response function. fMRI maps were transformed into Talairach space and were segmented into 123 brain areas. Maximum and average correlation coefficients (CC) were calculated for each area using Matlab (Mathworks Inc.). Student t-test was employed to identify statistically significant (p< 0.1) differences in activation.

Results

1. Single Voxel Timecourse

2. Functional Activation Maps

3. Inter-Group Comparison

Discussion
In this preliminary study, event-related fMRI of a set-switching task demonstrated promising findings. The PD patients demonstrated functional differences during the performance on the task in frontal, temporal, and cerebellar cortex, in addition to areas involved in reward and the planning of movements. Our preliminary findings suggest that fMRI is capable of measuring functional differences in PD patients and age-matched controls during the performance of a set-shifting task.

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