Photopic and mesopic visual resolution in Parkinson’s disease patients with and without freezing of gait

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Parkinson’s Disease

- Progressive neurodegenerative disease that is characterized by motor problems
  - Tremor of limbs
  - Slowed movement (bradykinesia): simple tasks become difficult and take longer to accomplish.
    - Steps could become shorter or drag feet
    - Difficulty getting out of a chair
  - Rigid muscles
  - Impaired posture and balance
  - Loss of automatic movements.
    - Decreased ability to perform unconscious movements, including blinking, smiling or swinging arms when walking.
  - Speech changes:
    - speak softly, quickly, slur or hesitate before talking.
Parkinson’s Disease

- Primary neuropathology is the degeneration of dopaminergic neurons in the subthalamus:
  - substantia nigra
    - Signals to carry out Movement are modulated by thalamus, basal ganglion and subthalamus
Parkinson’s Disease

- If the neurodegenerative process is located primarily in the subthalamus and basal ganglion
  - Executive functions and emotions could be affected

- If the process affects primarily dopaminergic neurons
  - Frontal eye fields & sensory visual processes could be affected
Freezing of Gait

- A brief, episodic absence or reduction of forward progression of the feet despite the intention to walk
  - Characteristic appearance of the feet making quick stepping movements in place.
  - Freezing as they try to pass through a narrow doorway or hallway is one of the hallmark symptoms
  - Most of PD who display FOG are in the later stages of PD, but 26% are in the early stages of PD

- FOG seems to develop independently of PD
- Medication and rehabilitation help
  - but not to the same extent as other PD symptoms
Freezing of Gait

- FOG patients have more visuospatial judgement and motion perception errors which are correlated with walking performance.
- Removing/reducing visual cues will also increase the number of FOG occurrences.
- Could be poorer processing within the occipito-parietal dorsal stream i.e. “where” vision
  - or integrating the “where” information with movement.
Previous studies

- Suggest deficits with in the occipito-parietal dorsal stream processing (the “where” visual stream).
  - Interested in whether these deficits would occur in more basic visual functions
## Methods

### Participants

<table>
<thead>
<tr>
<th>Groups</th>
<th>FOG</th>
<th>non-FOG</th>
<th>Healthy Controls</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample Size (N)</td>
<td>22</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>(Male/Female)</td>
<td>(14/8)</td>
<td>(19/6)</td>
<td>(8/17)</td>
</tr>
<tr>
<td>Age</td>
<td>72.31</td>
<td>67.52</td>
<td>70.43</td>
</tr>
<tr>
<td></td>
<td>(6.9)</td>
<td>(9.4)</td>
<td>(7.67)</td>
</tr>
<tr>
<td>Cognitive (MoCA) Score</td>
<td>24.95</td>
<td>25.76</td>
<td>26.48</td>
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<tr>
<td></td>
<td>(4.27)</td>
<td>(2.18)</td>
<td>(2.16)</td>
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<tr>
<td>Severity (UPDRS) Score</td>
<td>22.41</td>
<td>19.96</td>
<td>NA</td>
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<tr>
<td></td>
<td>(7.94)</td>
<td>(9.58)</td>
<td></td>
</tr>
<tr>
<td>Duration of the Disease</td>
<td>10.52</td>
<td>8.08</td>
<td>NA</td>
</tr>
<tr>
<td></td>
<td>(6.6)</td>
<td>(6.35)</td>
<td></td>
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</tbody>
</table>
Methods

- Participants
- Excluded if
  - Visual acuity worse than 6/9 (20/30)
  - History of diabetes
  - Nystagmus
  - Strabismus,
  - Other neurological deficits
Tests

- Visual Resolution
  - High and Low Contrast Letter Acuity
  - Vernier Acuity (misalignment/position judgments)
  - Contrast Sensitivity (large letters)

- Photopic (~120 cd/m²) and Mesopic (~1.2 cd/m²)
Results

- **Visual Acuity**
  - For all:
    - worse for low contrast and low light
  - Controls better than both PD groups,
  - FOG subjects had the largest decrease at low contrast and low light
Vernier Acuity

- Worse in lower light for all groups
- No differences between horizontal and vertical alignments
- FOG showed largest reduction at both light levels.
  - Decrease is greater in low light levels
Contrast Sensitivity

- Similar trend.
  - FOG worse especially at low light levels.
Multinomial Logistic Regression

- Performed to determine the tests that best discriminate between groups

<table>
<thead>
<tr>
<th>Test</th>
<th>Chi-Square</th>
<th>df</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>7.448</td>
<td>2</td>
<td>0.024</td>
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<tr>
<td>Contrast Sensitivity Mesopic</td>
<td>16.704</td>
<td>2</td>
<td>0.000</td>
</tr>
<tr>
<td>Vertical Vernier Acuity Mesopic</td>
<td>8.424</td>
<td>2</td>
<td>0.015</td>
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<tr>
<td>Low Contrast VA Photopic</td>
<td>6.975</td>
<td>2</td>
<td>0.031</td>
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<tr>
<td>Horizontal Vernier Acuity Mesopic</td>
<td>6.638</td>
<td>2</td>
<td>0.036</td>
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</tbody>
</table>
Conclusions

- Visual function in PD subjects is compromised more than acuity matched controls, especially in lower light levels and in FOG PD subjects.

- Although PD is considered to be a movement disorder, results suggest they could benefit in increased lighting and contrast.
  - Raises the issue whether all individuals with balance/mobility problems, but "normal visual system" would also benefit increased lighting/contrast.

- FOG losses for low contrast objects and alignment tasks add additional evidence that occipital-parietal pathway may be affected to a greater extent.

- Another possibly is that the eye movements become unstable and irregular in low light levels and smears the retinal images.
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