Magnocellular and Parvocellular Pathway Contrast Gain in Patients with Optic Neuritis

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Optic Neuritis

- Clinically, optic neuritis presents with a rapid loss of vision in a young (<40 years)
- Usually unilateral
- During the attack, lymphocytes and monocytes infiltrate the optic nerve, which is an extension of the central nervous system
- Immune cells directly damage myelin

Recovery

- By one year up to 95% have at least 20/40 vision
- However there are still tell tale signs of the disease, even with 20/20 vision

Purpose

- To evaluate chromatic and achromatic contrast gain of the two cell classes involved in optic neuritis:
  - Magnocellular (MC) pathway cells
  - Parvocellular (PC) pathway cells

  - MC: Achromatic
    - Low spatial resolution
    - High temporal resolution
  - PC: Chromatic (Achromatic)
    - High spatial resolution
    - Low temporal resolution

Rationale

- Use three psychophysical paradigms developed by Joel Pokorny and Vivianne Smith
  - Paradigms known as: PULSED (achromatic) STEADY
  - Paradigms differentiate MC- and PC-pathway responses based on their unique contrast gain signatures
    - Contrast gain refers to how rapidly a response changes with changes in contrast

Pulsed Paradigm (Achromatic)

Pokorny & Smith (1997)

PC - Achromatic

Contrast Gain Function
A model based on primate PC and MC physiology describes the data

Change in contrast gain = change in slope
Change in sensitivity = vertical shift

Seven Patients have been studied to date
- Patients are >6 months from episode
- Better than 20/80 vision
- Unilateral or bilateral optic neuritis
- Pre-testing clinical exam:
  - Visual acuity, Visual fields (Sita 24-2), Ishihara

Clinical examples of the different effects of Optic Neuritis on the MC-and PC-pathways

State whether unilateral (or bilateral) ON ??
Results so far

- Patients with Optic Neuritis can show:
  - Differences between Left and Right eyes
    - Deficits in the clinically non-affected eye
  - Decreased MC & PC - contrast gain
    - contrast sensitivity
  - Differential change in chromatic & achromatic contrast gain

- Decreased contrast gain means fewer ganglion cell spikes are generated to a normally threshold stimulus. Therefore greater contrast required to reach threshold.

Future Plans

- Study at least 15 patients
- Compare data with age- gender- and race-matched controls
- Evaluate relationship between contrast gain and sensitivity to explore relative level of retinal and post-retinal losses
## Optic Neuritis Model Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Normal*</th>
<th>Patient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Csat</td>
<td>0.12 to 0.25</td>
<td>0.12 to 0.25</td>
</tr>
<tr>
<td>Achromatic Vertical Scale - MC</td>
<td>-1.9 to -1.6</td>
<td>-1.9 to -1.6</td>
</tr>
<tr>
<td>Achromatic Vertical Scale - PC</td>
<td>0.8 to 1.00</td>
<td>0.8 to 1.00</td>
</tr>
<tr>
<td>Chromatic SAT</td>
<td>2.51 to 12.00</td>
<td>2.51 to 12.00</td>
</tr>
<tr>
<td>K (delta/Rmax)</td>
<td>0.006 to 0.035</td>
<td>0.006 to 0.035</td>
</tr>
</tbody>
</table>


** Larger values mean decreased contrast gain (V-shape flattens)
** Vertical Scale - MC: Values closer to zero (less negative) indicate greater sensitivity loss
** Vertical Scale - PC: Larger values indicate greater sensitivity loss
** SAT: Larger values mean decreased contrast gain (interpretation also dependent on K-value)
** K (delta/Rmax): Larger values indicate greater sensitivity loss (interpretation also dependent on SAT-value)