UNIVERSITY of HOUSTON
COLLEGE of OPTOMETRY

MS Eye CARE
Multiple Sclerosis Eye Center for Analysis, Research and Education

Multifocal Visual Evoked Potentials (mfVEP) and Ganglion Cell Inner Plexiform Thickness (GCIPT) in Relapsing Remitting Multiple Sclerosis (RRMS)

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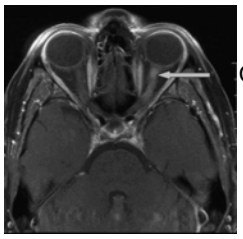
Visual system in MS

- Optic neuritis (ON): Inflammatory demyelination of the optic nerve.
  - >50% MS patients affected at some point (Beck et al 2003)



Optic nerve enhancement during acute event

Image source: Frohman et al 2010

- Evidence of subclinical demyelination and axonal loss in MS lesions (Prineas et al 1984)
- Good model for MS (Frohman et al 2008, Costello 2013)
  - Symptomatic
  - Several functional and structural tests available

Clinical tests to assess visual system

Functional tests

Subjective

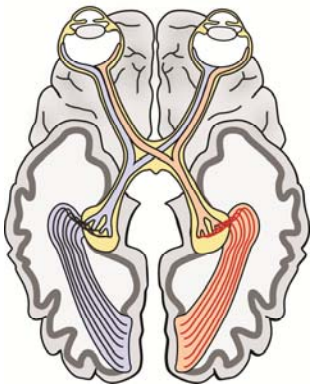
- Contrast sensitivity (CS)
- Humphrey visual fields (HVF)

Objective

- Traditional visual evoked potential (tVEP)
- Multifocal visual evoked potential (mfVEP)

Structural tests

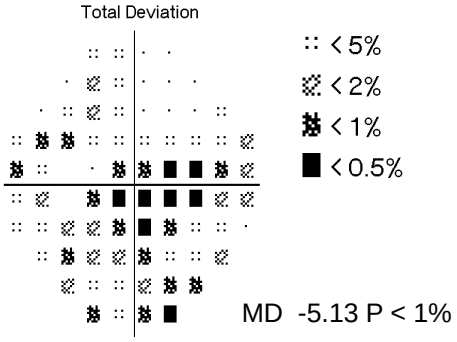
- Optical coherence tomography (OCT)



Contrast sensitivity

- Pelli-Robson contrast measured from 0 to 2.25 log units in 0.15 log unit steps

Humphrey visual fields



- HVF 30-2 or 24-2 were performed.

Image source: http://www.psych.nyu.edu/pelli/pellirobson

Visual evoked potential (VEP)

- Non-invasive measure of electrical responses generated by visual cortex
- **Amplitude**: Loss of nerve fibers reduces amplitude
- **Latency**: Demyelination delays signals

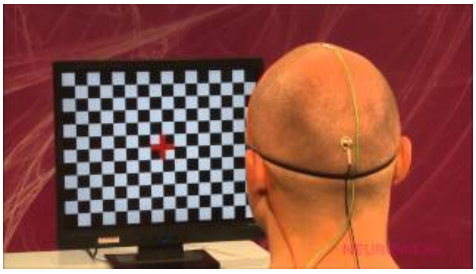
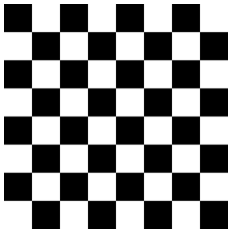


Image source: Sensory testing systems

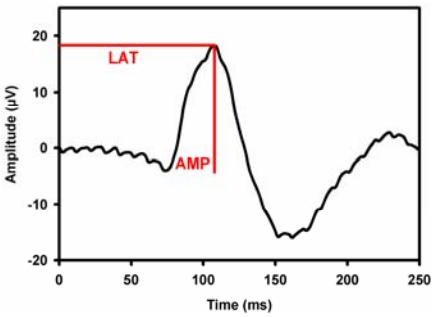
Traditional VEP

Pattern-reversal stimulus



- 15', 60' and 120' check sizes
- 2 reversals per second

Response

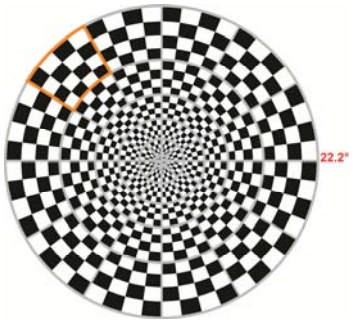


- P100 amplitude and latency measured

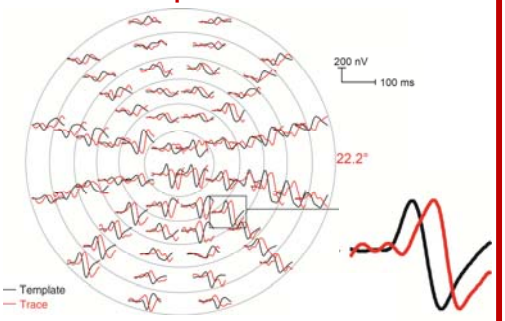
- Provides summed responses dominated from macular region

Multifocal VEP (MfVEP)

Stimulus



Response



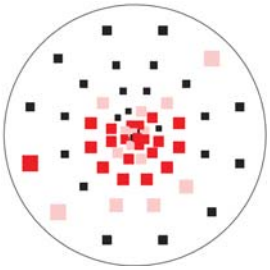
- 60-sectors,scaled for cortical magnification
- Multiple VEPs simultaneously recorded from 60 local regions
- Amplitude: Log signal-to-noise ratio (logSNR)
- Relative latency: Cross-correlation of subject's waveform and normative template

Hood et al 2004

MfVEP probability plots

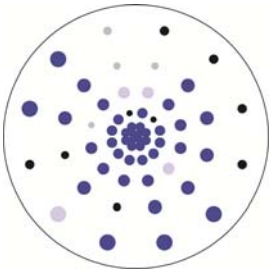
- Responses from each sector are compared to the norms and marked as normal or abnormal
- Topographic read out of the extent of damage

AMP



Red: Left eye abnormal

LAT

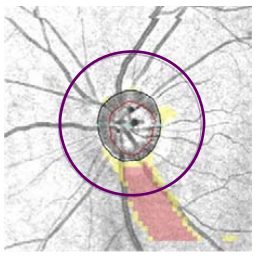


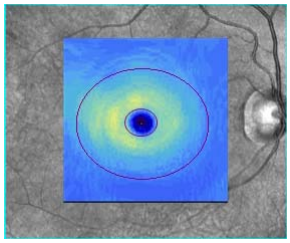
Blue: Right eye abnormal

Saturated: p<0.01
Desaturated: p<0.05

SD-OCT

Peripapillary retinal nerve fiber layer thickness (RNFLT) and macular ganglion cell inner plexiform layer thickness (GCIPT) measures were obtained





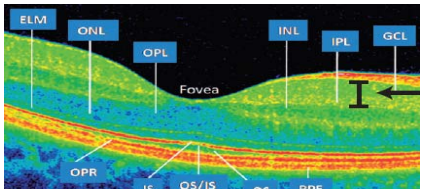


Image Source
Leung et al 2013
Syc et al 2011

Purpose

To compare various functional and structural measures in RRMS eyes, especially those without a history of ON

Methods

- **90 RRMS patients** had CS, HVF, mfVEP, OCT
- Mean age: 40.8 ± 10.5 years
- Mean MS duration: 6.5 ± 7.4 years
  - **58 ON eyes** (last ON>6months)
  - Time since last ON: 3.8 ± 5.0 years
  - **105 non-ON eyes**
- 30 patients (19 ON, 30 non-ON eyes) also had tVEP
- 40 age-matched normal controls

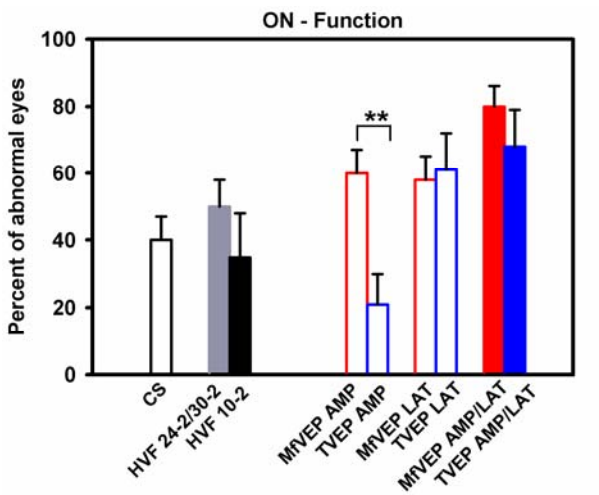
Analysis

Criteria for classifying MS eyes as abnormal

- CS , MfVEP and tVEP classified as abnormal if <5% of norms
- HVF (MD), GCIPT and RNFLT classified as abnormal if <5% of machine norms

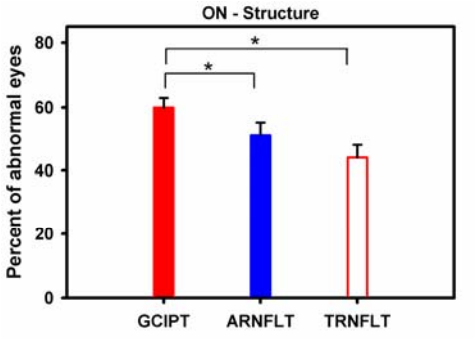
Results

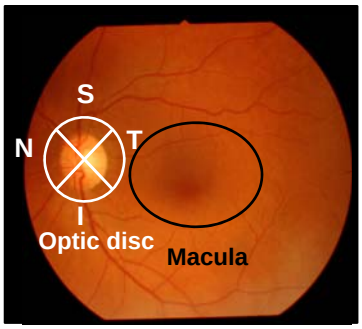
ON: Percent of abnormal eyes detected by functional tests



** p<0.01

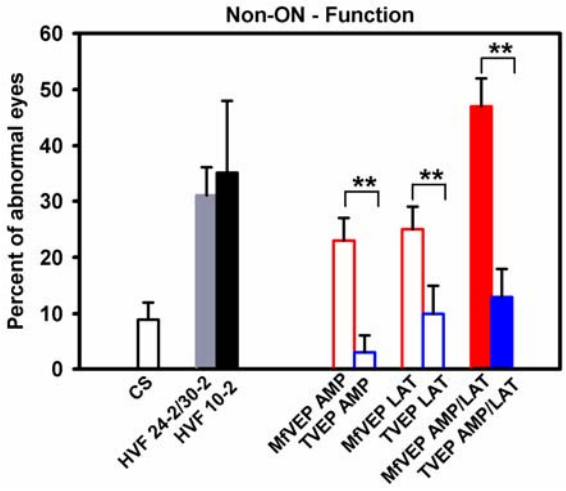
ON: GCIPT detected more abnormal eyes than RNFLT





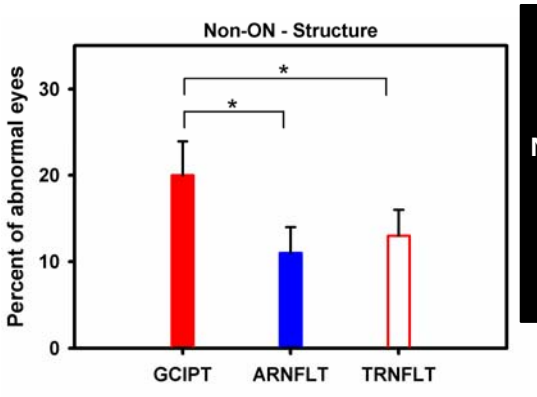
*** p<0.05**

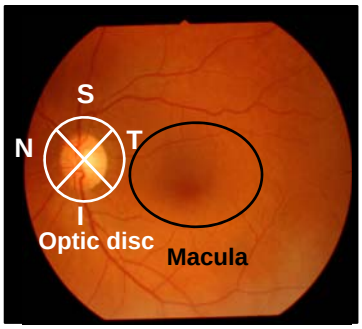
Non-ON: MfVEP detected more abnormal eyes than TVEP



**** p<0.01**

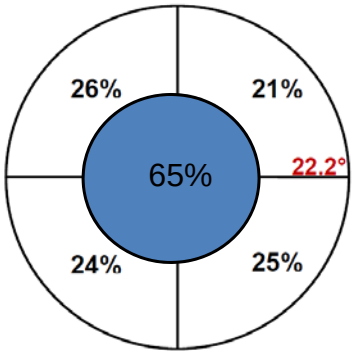
Non-ON: GCIPT detected more abnormal eyes than RNFLT

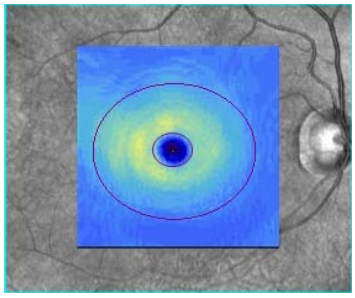




*** p<0.05**

Among non-ON eyes with abnormal mfVEP LAT, 65% had delay in the central region that corresponds to GCIPT





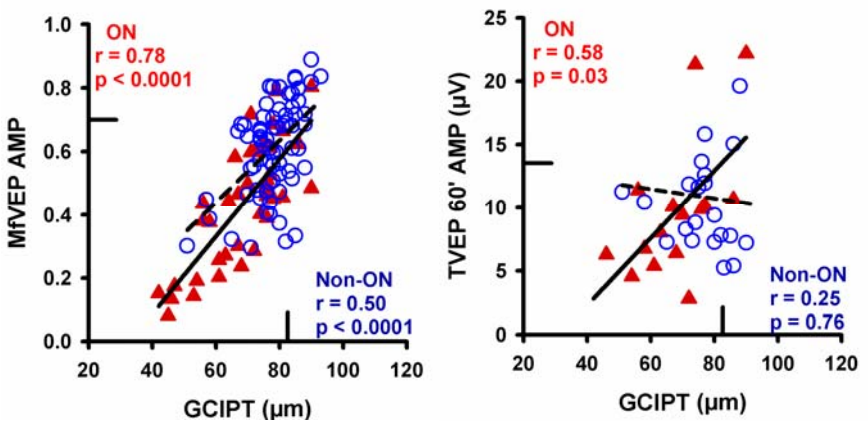
MfVEP region
7.3° horizontal 6.0° vertical*

GCIPT region
8° horizontal 6.7° vertical

*Scaled for retinal ganglion cell displacement (Drasdo et al 2007)

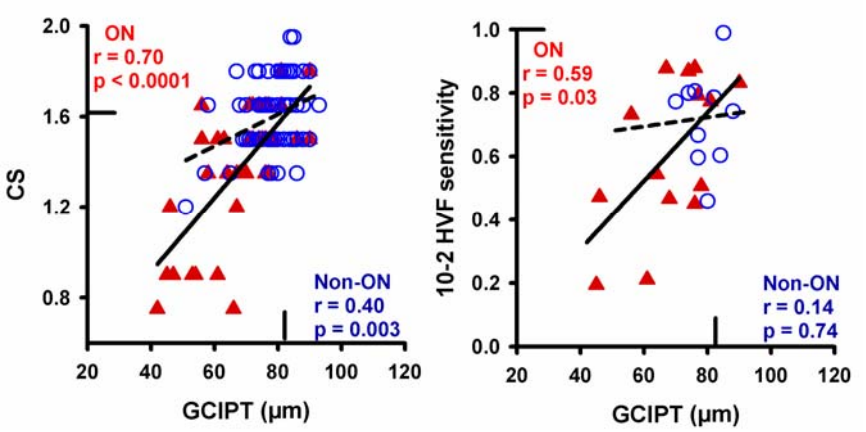
Correlation between functional tests vs GCIPT

MfVEP: Correlated with GCIPT in both ON and non-ON
TVEP: Correlated with GCIPT in ON but not in non-ON



CS: Correlated with GCIPT in both ON and non-ON

HVF: Correlated with GCIPT in ON but not in non-ON



Conclusion

- MfVEP detected more abnormal eyes than other functional tests (3 times more than tVEP in non-ON)
- GCIPT detected more abnormal eyes than ARNFLT and TRNFLT
- Pelli-Robson CS and mfVEP are more reflective of the structural alterations than HVF and tVEP, especially in non-ON eyes
- MfVEP and GCIPT offer complementary information on the integrity of the visual pathway and are useful for detecting subclinical neuronal defects in MS

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- Courtney Perry
- Bobby Saenz

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