A Novel Electrophysiological Battery for the Assessment of Visual Dysfunction in Multiple Sclerosis

Roseann Archetti[1], Kasey Siegel[1], Frederick W. Foley[1,2], and Vance Zemon[1]

[1]Ferkauf Graduate School of Psychology, Yeshiva University, Bronx, NY; [2]Holy Name Medical Center, MS Center, Teaneck, NJ

Abstract

Objectives: The current work aims to establish a battery of electrophysiological techniques that rapidly and objectively assess function in select neural pathways and mechanisms in patients with MS at both retinal and cortical levels.

Methods: Patients with relapsing-remitting MS and age-matched controls were tested on an electrophysiological battery using EvokeDx device (Konan Medical USA), which presented visual stimuli on a calibrated organic LED display, recorded amplified electroencephalographic (EEG) and electroretinographic (ERG) signals, and applied multivariate statistical analyses on the data in the frequency domain following a discrete Fourier transform. Stimuli and analytic techniques were designed to tap select neural pathways and mechanisms (e.g., retinal ganglion cells, magnocellular ON and OFF pathways, lateral inhibitory processes).

Results: Preliminary findings indicate that frequency-domain techniques capture neural deficits in rigorous, quantitative measures that are sensitive to dysfunction in the visual pathways.

Conclusions: The objective, rapid electrophysiological tests included in this battery capture the effects of the disease process and may be of value in identifying early-stage cases ahead of conventional measures, and may be able to monitor the progression of the disease as well as evaluate the effects of various treatments.

Background

- Visual impairment is a key component of the MS disease process, with disturbances along the afferent visual pathway occurring in 80% or more of individuals with MS at some point during their disease course.[1]
- MS lesions can affect any part of the neural networks involved in vision and, therefore, can often cause a variety of neuro-ophthalmic manifestations. [2]
- While acute optic neuritis (AON) is often a primary manifestation, visual impairments characterized by structural, axonal and other neuronal loss do occur in patients without a history of ON. [3]
- Compromised components of the visual system have been associated with worsening of the disease.
- The frequency with which the afferent visual pathway is involved in the disease process of MS makes it a useful model of the pathophysiological mechanisms involved.

Methods

- Stimulation, data collection & analysis performed using EvokeDx system
- Viewing: Monocular (VEP) and binocular (ERG) with viewing distance of 65 cm
- Visual acuity of 20/30 or better verified with Sloan ETDRS chart
- EvokeDx system automatically applies a technique known as a discrete Fourier transform to extract a set of frequency components from the VEP response. Each component is quantified in terms of sine and cosine coefficients, or in terms of computed amplitude and phase values.
- Magnitude-squared coherence (MSC) is a relative measure of signal strength computed for distinct frequency bands.
- Conventional measures, peak-to-trough N75-P100 amplitudes and latencies for the negative peak (N75) and positive peak (P100) will be also examined for the transient VEP.
- Ten individual responses were analyzed by calculating sine and cosine coefficients, and a mean amplitude and mean phase, for each individual frequency component. [4,5]

VEP Electrode Placement:
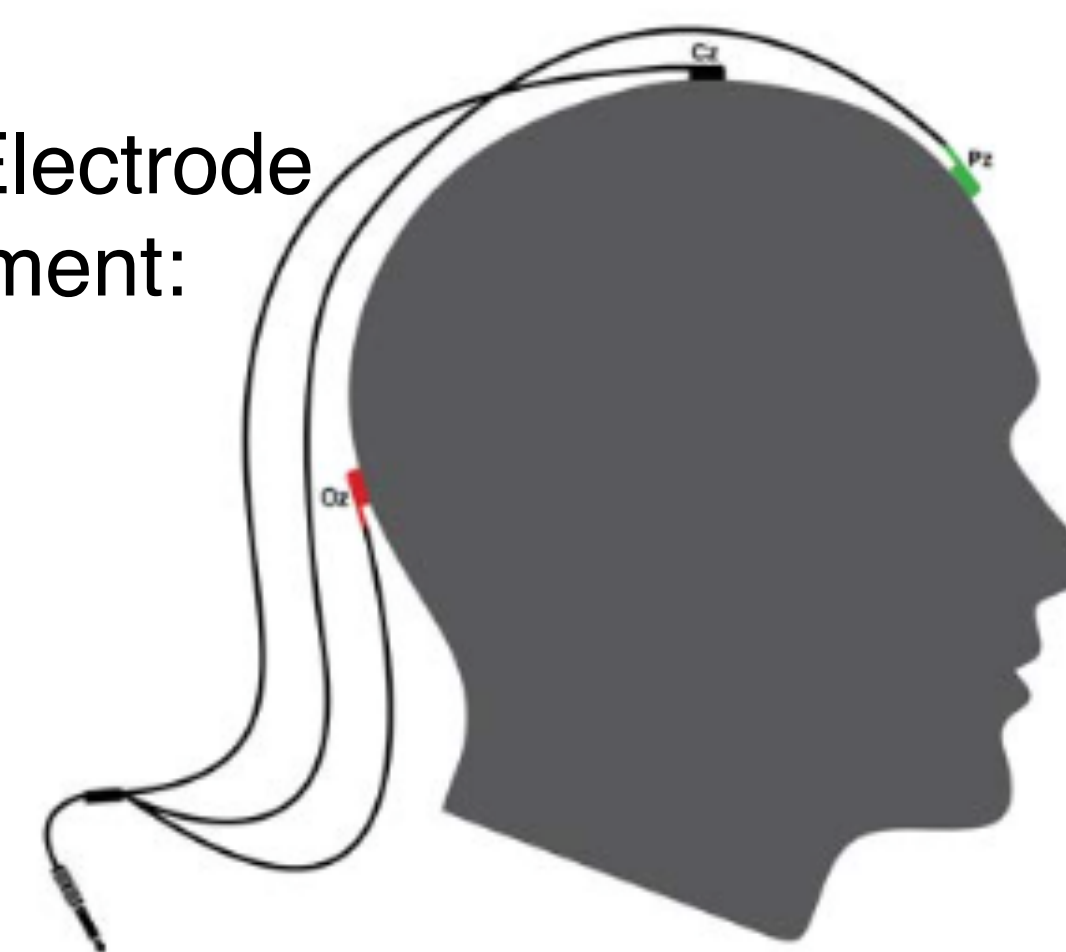
ERG Electrode Placement:
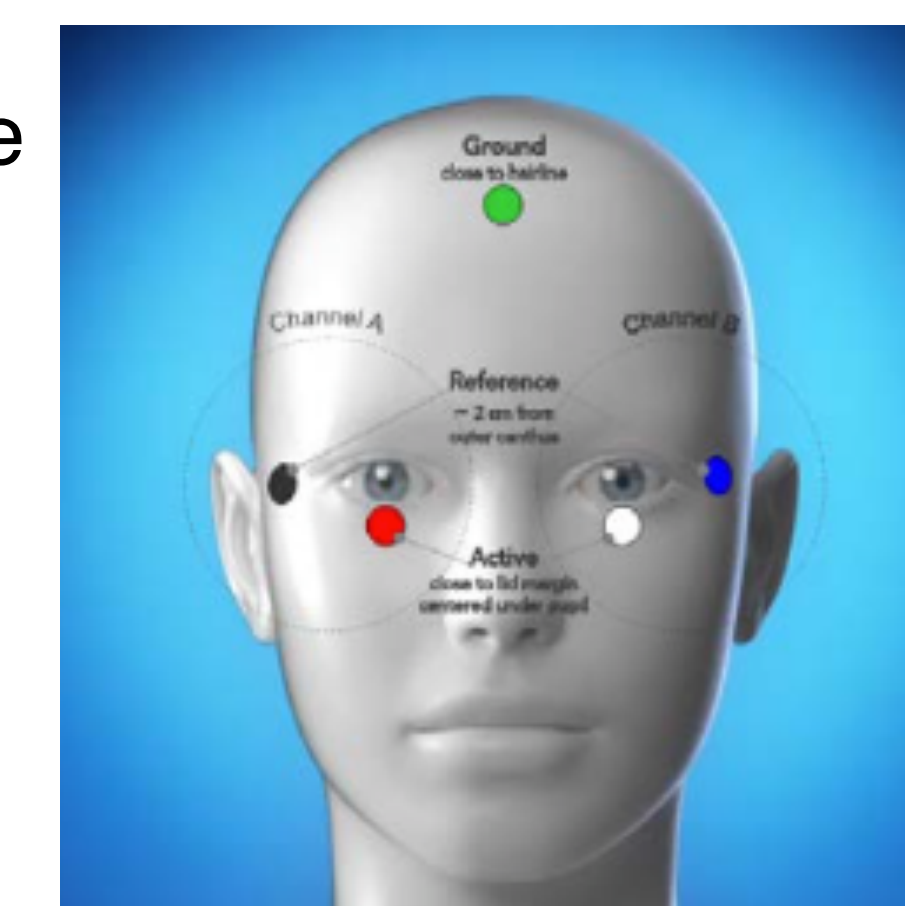
Conclusions & Implications

- This novel approach using a battery of short-duration VEPs is expected to yield sensitive and objective indices of neural pathway function in healthy controls and adults with MS and CIS.
- We expect to be able to identify relationships between functional neural mechanisms of vision and the MS disease process.

Preliminary Results

Transient VEP Response — Waveform / MSC

Test A: Healthy Control Participant
Test B: Multiple Sclerosis Participant
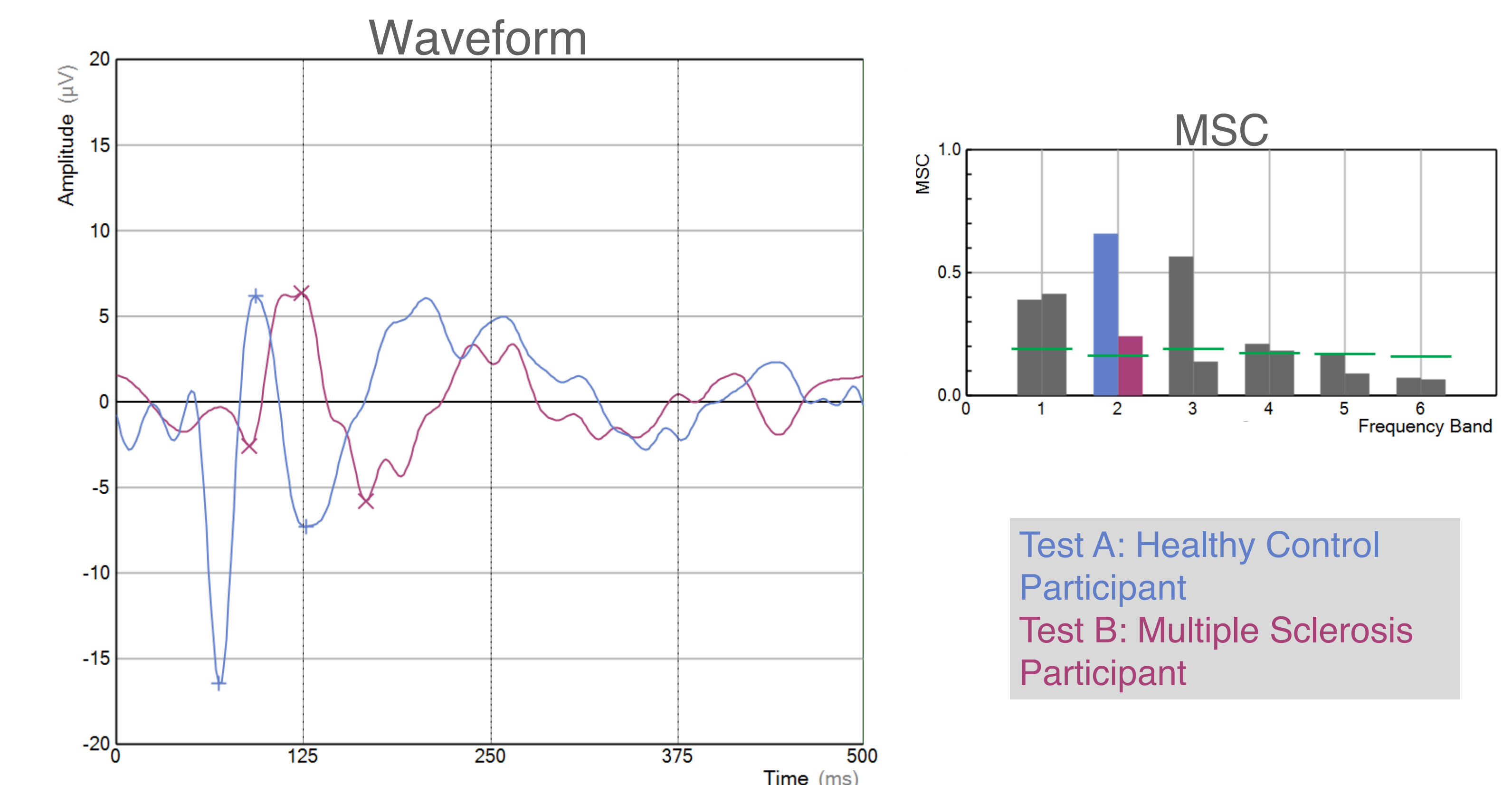
		N75	△	P100	△	N135
AMP (µV)	Test A (OD) +	-16.43	22.61	6.18	13.46	-7.29
	Test B (OD) ×	-2.58	8.92	6.34	12.14	-5.80
	△		13.69		1.33	
Time (ms)	Test A (OD) +	68		93		127
	Test B (OD) ×	88		123		167
	△	-20		-30		-40

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