Andrew Metha, University of Melbourne, Australia

Bio:

Andrew Metha is currently an Associate Professor in the Department of Optometry and Vision Sciences at the University of Melbourne, where he has taught at all levels in the Bachelor and now new Postgraduate Optometry Degree courses. His first degree from Monash University was a Bachelor of Science (Physics and Mathematics), followed by an Optometry undergraduate degree from the University of Melbourne where he also obtained his PhD. Andrew currently holds a therapeutically-endorsed optometry registration in Australia. He is an eclectic vision scientist: first gaining expertise in psychophysical methods of understanding visual processes during his PhD; then branching into single and multi-cell electrophysiological recordings in primate and other mammalian primary visual cortex to investigate adaptation and brain plasticity; and most recently his laboratories use Adaptive Optics (AO) to image cellular-level structure and function in living human and animal eyes. He joined the University of Melbourne in 2000 after serving postdoctoral positions in Canada (McGill Vision Research, Montreal), the University of Rochester's Centre for Visual Science (NY, USA) and the Psychobiology Laboratory in Canberra's ANU. With this diverse range of exposure and experience, Andrew brings a multi-disciplinary approach to bear on the question: 'how do we see?'

Presentation Title:

In-vivo Human Adaptive Optics Imaging of Retinal Capillary Structure and Function

Abstract:

Efforts to increase the spatial resolution of in-vivo human retinal imaging systems by using Adaptive optics (AO) have already brought many benefits for the study of both normal and pathological vision, principally by making visible photoreceptor cells and elements of the vascular tree. There is still much work to be done to render visible the normally more transparent structural elements of the retina such as bipolar, horizontal, ganglion and glial cells, but there are hopeful expectations that optical coherence tomography, phase-contrast, multiple-scatter and polarization-sensitive methods will fill this gap. While enhanced spatial contrast by itself allows observations of microscopic structural details, study of retinal physiological processes require sequential images to be gathered in rapid succession, preferably using light that perturbs function in known ways if at all. Rapid imaging also obviates the challenge of studying detailed structure and function in living eyes that make incessant fixational eye movements in the form of tremors, drifts and micro-saccades. In real imaging systems, spatial and temporal resolution must be traded against each other, but a balance can be struck for specific purposes. In our laboratory we use a flood-illumination AO-ophthalmoscope equipped with a sensitive, high frame-rate areal camera. While limited in spatial contrast, the temporal resolution afforded allows direct and distortionless observation of single red and white blood cells as they traverse the inner retinal vasculature. We have used this ability to observe directly the stimulus-induced re-distribution of blood flow through the retina's narrowest vascular elements: pre-capillary arterioles, the capillaries themselves, and post-capillary venules. We characterized the range of immediate light-induced changes of vessel diameters to

confirm the action of neurovascular coupling (functional hyperaemia) at the capillary level in living humans, which gives rise to the blood oxygen-level dependent (BOLD) signal underpinning functional magnetic resonance imaging (fMRI). We have also begun a survey documenting the pulsatile nature of individual red cell flow through single capillaries, and how this is related to cardiac output. A full characterization of pulsatility heterogeneity in normal retinas will permit comparisons to be made with diseased eyes, such as in diabetes where increased cell adhesion is hypothesized from histological studies in animal models. Watching blood flow regulation mechanisms in action is powerful since it gives insights into the normal function of the vascular system, and understanding this is significant since failure such regulatory processes potentially underlies the primary pathologies of diabetes (in the eyes, kidneys and extremities), hypertension, stroke, dementia, epilepsy, migraine, multiple sclerosis and glaucoma.