Type of communication: Oral

Submitted by: VOHNSEN, Brian
University College Dublin
brian.vohnsen@ucd.ie

What's new with the Stiles-Crawford effect?

Brian Vohnsen

The Stiles-Crawford effect (SCE) manifests an impact of light-to-photoreceptor coupling prior to neural processes on vision. Thus, the visibility of light depends strongly on its angle of incidence at the retina effectively limiting the eye pupil by an apodization function. This apodization, the Stiles-Crawford function, has commonly been assumed to be Gaussian matching perfectly with single-mode cylindrical waveguide expectations for the photoreceptors, but when higher-order modes are present the apodization becomes more rectangular mirroring the limited cone acceptance angle. We have measured the SCE using a semi-automated characterization technique across the visible spectrum [1] and compared the obtained characteristic directionality parameter with that of the waveguide model. The results are discussed in relation to single- and multimode characteristics of the photoreceptor cones.
The fact that the photoreceptors are sensitive to the angle of incidence implies that the retina is sensitive to the wavefront and therefore the phase gradient of light. This reduces the visual impact of aberrations [2] but perhaps most strikingly it also implies that the Stiles-Crawford function with annular apertures (and thus the integrated SCE) is completely cancelled once coherent light is used [3]. The angular sensitivity can be explored at the level of individual cone photoreceptors using confocal SLO to probe their directionality and such results will be discussed. Finally, a liquid-filled photonic crystal fibre has been analyzed as a simulation model producing waveguide conditions that resemble those of the photoreceptor cones but using temperature as a variable for tuning from single- to multimode characteristics [4].

Acknowledgments
I wish to thank Dr. Diego Rativa and Mr. Benjamin Lochocki for their contributions to the studies presented and the funding provided by Science Foundation Ireland (grants: 07/SK/B1239a and 08/IN.1/B2053) and Enterprise Ireland (grant: PC/2008/0125).

References
[1] Lochocki, B., Rativa, D. and Vohnsen, B. (2011) , Spatial and Spectral Characterization of the First and Second Stiles-Crawford Effects using Tuneable Liquid-Crystal Filters, J. Mod. Opt. (in press).
[2] Vohnsen, B. (2007) Photoreceptor Waveguides and Effective Retinal Image Quality, J. Opt. Soc. Am. A 24, 597-607.
[3] Vohnsen, B. and Rativa, D. (2011) Absence of an Integrated Stiles-Crawford Function for Coherent Light, J. Vision 11, 1-10.
[4] Rativa, D. and Vohnsen, B. (2011) Simulating Human Photoreceptor Optics using a Liquid-Filled Photonic Crystal Fiber, Biomed. Opt. Express 2, 543-551.