

## TFM 2025-26 | Generative AI for multi-cue stimuli detection methods in visual perception

Visual cues that drive emmetropization, the postnatal eye growth, are rarely simple, uniform stimuli; instead, they consist of complex, overlapping image features such as contrast, spatial frequency, blur adaptation, and chromatic cues. Each of these may influence emmetropization in different ways, but current methods cannot disentangle their individual or combined effects. Moreover, neural adaptation processes modify each individual's visual perception thresholds. For example, blur adaptation<sup>1</sup> may modify the retina's sensitivity to defocus, especially in early-onset myopes, while chromatic blur<sup>2</sup> might help detect the sign of defocus blur<sup>3</sup>.

Generative Artificial Intelligence (AI) might help disentangling the individual roles of optical cues in visual perception, via synthesizing visual environments that selectively amplify or suppress specific cues, thereby creating controlled, adaptive testbeds for studying perceptual plasticity. By iteratively combining real behavioral data with generative modeling, the project will move beyond descriptive correlations to actively probing causal mechanisms of how visual salience interacts with near work, outdoor exposure, and other risk factors.

In this collaborative project, between OPTICAL groups

BIOSIM - BIOPhotonics & Smart IMaging Lab, Institute of Optics of the Spanish National Research Council (CSIC) | María Viñas Peña. Development of novel imaging techniques and computational methods to investigate the visual system, with particular focus on adaptive optics, advanced optical coherence tomography, and multimodal functional imaging. BIOSIM works at the interface of photonics, neuroscience, and ophthalmology, translating high-resolution optical technologies into clinical tools for early diagnosis and personalized management of eye and vision-related neural diseases.

VISILAB – Vision, Image & Signal Processing Lab, Escuela Técnica Superior de Ingeniería, Universidad de Castilla-La Mancha (UCLM) | Dr. María Gloria Bueno García. The group works on computational vision, imaging, and signal processing with applications to the visual system. Their research includes development of algorithms for image enhancement, restoration, and analysis; optical modelling of ocular structures; machine learning methods for retinal and brain imaging; and validation of these tools for diagnostics and monitoring of visual disorders. VISILAB bridges engineering, computational modeling, and ophthalmology to enable earlier detection of disease, improve image-based biomarkers, and support more precise, non-invasive diagnostic strategies.

the candidate will work in the development of a proof-of-concept of a multi-cue perceptual test, using controlled generative AI visual stimuli targeting key optical cues, will be developed using MATLAB/Psychtoolbox/ISET BIO, tailored to incorporate variability across cue types and refractive profiles.

- 1 Vinas, M., Sawides, L., de Gracia, P. & Marcos, S. *Perceptual adaptation to the correction of natural astigmatism. PLoS ONE* **7**, e46361 (2012).
- 2 Vinas, M., Dorronsoro, C., Cortes, D., Pascual, D. & Marcos, S. *Longitudinal chromatic aberration of the human eye in the visible and near infrared from wavefront sensing, double-pass and psychophysics. Biomed Opt Express* **6**, 948-962, doi:10.1364/BOE.6.000948 (2015).
- 3 Taylor, C. P., Shepard, T. G., Rucker, F. J. & Eskew, R. T., Jr. *Sensitivity to S-Cone Stimuli and the Development of Myopia. Invest Ophthalmol Vis Sci* **59**, 4622-4630, doi:10.1167/iovs.18-24113 (2018).

**Impact & opportunities.** The candidate will have the opportunity to learn and practice different methodologies, working in an interdisciplinary and international environment, with great scientific, clinical and industrial impact, with opportunities for academic and business professional development.

**Candidate's profile.** We are looking for a candidate with an excellent academic record, motivation for experimental and multidisciplinary work, work capacity, and excellent communication skills (in English and Spanish). The selection process includes an in-person interview. Motivation to pursue a career in Optics and Photonics will be valued.

**Contact.** Maria Vinas-Pena, PhD (maria.vinas@csic.es), Gloria Bueno, PhD (Gloria.Bueno@uclm.es), Gabriel Cristóbal, PhD (gabriel.cristobal@csic.es)