

Friday Materials Science Colloquia #11

Friday, April 19th 2024, 12 p.m.
Seminar room, U5 Building – via Roberto Cozzi 55, Milano

Lecturer: **Fabrizio Zeri**

Title: **Insights into optical correction of presbyopia with contact lenses: functional correlates in visual system**

Abstract:

One billion and 300 million people worldwide are currently affected by presbyopia.[1]
A spectacle-free option for presbyopia correction can be achieved with contact lenses (CLs) through two main strategies: simultaneous images, and monovision. Both strategies represent a “passive” approach to correcting the accommodation impairment due to presbyopia, referred to as pseudo-accommodation.
In the first option, different areas of the optical zone of a multifocal CL simultaneously provide optical powers for far and near distance correction over the entrance pupil of the eye. Since these areas are concentric and rotationally symmetrical, they induce a certain amount of positive, or negative spherical aberration that increases the depth of focus of the eye.
In the second option, it is induced an unbalanced correction across the two eyes: one corrected for far distance and the fellow for near distance.
However, from an optical point of view, the two strategies represent a form of “sub-optimal” correction which causes a contrast sensitivity loss. In the first case, the drawback is the spherical aberration induced by multifocal CLs that compromises the Optical Transfer Function of that optical system at the best focus. In the second case, with the monovision, the issue is the superimposition of an in-focus image with a blurred image across the eyes.
Patient satisfaction with multifocal CLs and monovision is not uniform and not fully predictable, and certainly linked to the way the visual system processes the optical information from the eyes. For these reasons, it is of paramount importance to study the functional correlates in the visual system in response to pseudo-accommodative solutions for presbyopes.
In the seminar, two lines of research in this area will be shown.
In the first one, the visual stress induced by monovision correction was investigated by examining the impact on reading behaviour through eye movement recordings. Findings showed that monovision does not alter the eye movement pattern when reading implies simple texts or lists of words calling for automatic visual processing. However, if the observer needs more in-depth controlled visual processing to read novel reading materials, an increased number of fixations and longer dwell times were observed.[2]
In the second one, the cortical activity of neophyte presbyopes corrected with multifocal CLs and monovision was examined by visual evoked potential recorded with high-density electroencephalography. [3] [4]
A loss of feedforward activity, in the primary visual cortex, that is compensated by extra feedback activity from other areas was produced by both monovision and multifocal presbyopia corrections. This compensation seems to be engaged in both visual and non-visual brain areas in monovision, and at different levels of processing of visual areas only, in the case of multifocal lenses, demonstrating that these kinds of visual corrections use different optical strategies to which the brain responds in different ways.

References:

- [1] BA Holden et al., Arch. Ophthalmol. 126, 1731-1739 (2008)
- [2] F. Zeri et al., Scientific reports, 8, 15574 (2018)
- [3] F. Zeri et al., The Journal of physiology, 596, 253-266 (2018)
- [4] F. Zeri et al., Contact Lens and Anterior Eye, 102137. (2024)