Fluctuations in both accommodation and fixational eye movements: covariation and effect of viewing distance

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Purpose:
Microsaccades and fluctuations of accommodations have been shown separately to be influenced by the stimulus, task and the cognitive load, while to be partially synchronous to heart rate. We study whether they might covariate over time and whether this might be an artefact or a specific function of the visual system during fixation.

INTRODUCTION:

- The rhythmic oscillation of accommodations occurs both at 0.5 Hz and at 2Hz (varies between subjects in 1.3-2.2 Hz) especially with the larger pupils. [1]
- The microsaccade frequency occurs typically at 1-2Hz
- Both have been shown to be modulated by target form, contrast, luminance and more recently spatial frequency.
- Do they covary over time? Do accommodation change after microsaccades as hypothesized in 1951 [3] ?
- How target distance affect each of these **instabilities** of **accommodation** and **eye movement**? (microsaccade rate, amplitude, BCEA…)

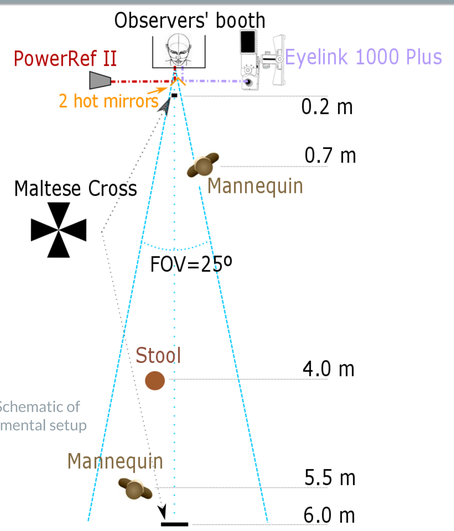


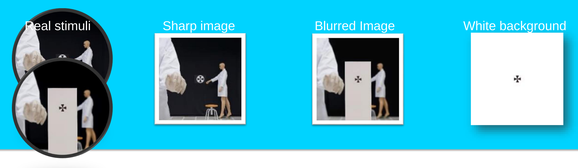
Figure 1: Schematic of the experimental setup

METHODS

- Fixational eye movements and accommodative fluctuations were recorded simultaneously on respectively the left and right eye of participants (fluctuations are known to be highly correlated in phase and amplitude on both eyes [2]).
- A PowerRef II recording at 25 Hz was synchronized to an Eyelink 1000 Plus sampling at 500 Hz.
- The stimuli were displayed binocularly at three distances (0D, 2D, 5D) along the midline of the two eyes. This is an improvement from a previous monocular experiment varying the peripheral cues and distance.
- The two instruments were electronically synchronized before each trial (Host PCs' Parallel port).
- 11 subjects (normal without glasses, age: 20-28) were asked to fixate during 10s a Maltese cross.

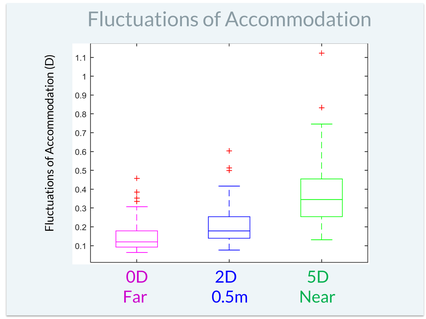
OBSERVATIONS from previous monocular experiment varying peripheral cues:

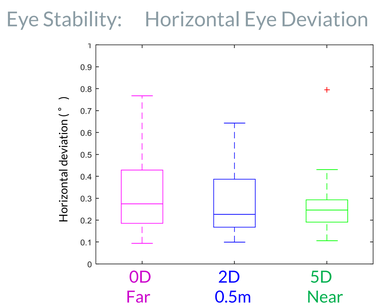
- ✓ Removal of peripheral cues and presence of artificial blur destabilize both the accommodative and fixational system for all tested subjects.
- ✓ Microsaccade frequency, rather than amplitude, seems particularly influenced by distance of fixation.
- ✓ Fluctuations of accommodation and eye movements appears coupled, both acting together during and for visual discrimination

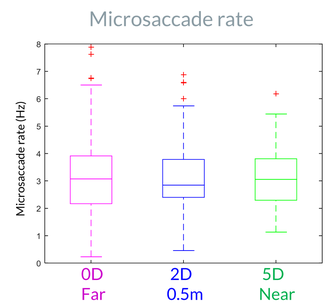


RESULTS

Effect of Viewing Distances

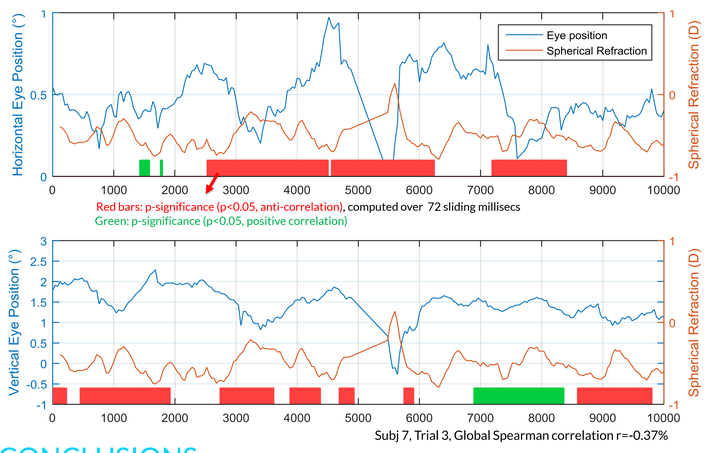




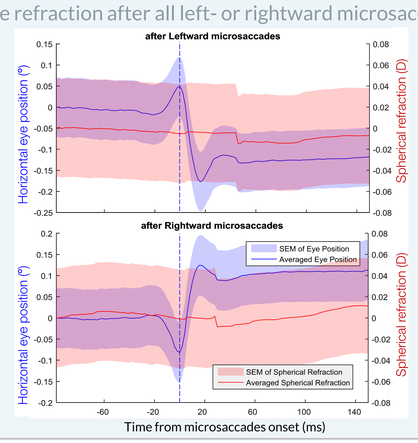


Note: *Microsaccade amplitude* and *BCEA* show no clear differences

Covariation over time



Average refraction after all left- or rightward microsaccades



CONCLUSIONS:

- ✓ While amplitude of fluctuations increase with distance, fixational eye deviations appear to decrease in amplitude.
- ✓ Over time, both horizontal and vertical position appear to covary with spherical refraction either in a correlated or anti-correlated manner.
- ✓ Two exclusive hypothesis can be deduced: a) both eye mechanisms act together during and for visual discrimination
  b) fluctuation of accommodation is a recording artefact due to fixational eye movements

References:

- [1] Charman, W. N., & Heron, G. (1988). Fluctuations in accommodation: a review.Ophthalmic and Physiological Optics, 8(2), 153-164.
- [3] Fincham, E. F. (1951). The accommodation reflex and its stimulus. The British journal of ophthalmology, 35(7), 381.
- [2] Campbell, F. W., & Westheimer, G. (1960). Dynamics of accommodation responses of the human eye. The Journal of physiology, 151(2), 285-295.

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