

Title: Implementing eye movement-based reading performance in presbyopia correction using multifocal contact lenses

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Purpose: Simple measures of visual acuity provide only a partial indication of functional vision in presbyopia correction. Many activities of daily living rely on reading, thus it is not surprising that complaints from presbyopes originate in reading difficulties. Here we present a new method, based on eye fixation analysis, to evaluate sustained reading performance in a presbyopic population using contact lenses (CLs) providing multifocal correction.

Setting: Laboratory of Optics and Vision (LOV), School of Medicine, University of Crete, Heraklion, Greece

Methods: Visual performance of thirty presbyopic volunteers (age: 50 ± 5 yrs) was assessed monocularly and binocularly wearing monthly disposable CLs (Air Optix Plus Hydraglyde, Alcon Laboratories): (a) at baseline with both eyes corrected with single vision lenses (b) two weeks following correction with aspheric multifocal lenses. LogMAR acuity was measured with ETDRS charts. Reading performance was evaluated using standard IReST paragraphs displayed on a screen (0.4 logMAR print size at 40cm distance). Eye movements were monitored with an infrared eyetracker (Eye-Link II, SR Research Ltd). Data analysis included computation of reading speed, fixation duration, fixations per word and percentage of regressions.

Results: Average reading speed was 250 ± 68 and 235 ± 70 wpm, binocularly and monocularly, with single vision lenses, improving statistically significantly to 280 ± 67 and 260 ± 59 wpm, respectively, with multifocal CLs ($p < 0.001$ in both conditions). Binocular advantage was statistically significant with both corrections ($p = 0.044, 0.001$) and was mainly due to the faster average fixation duration in binocular viewing (226 ± 40 vs. 254 ± 78 ms). Faster reading speed with multifocal correction was also accompanied with shorter average fixation duration ($p = 0.053$). Number of forward fixations per word and percentage of regressions did not differ between the binocular and monocular conditions, neither between the two correction modes.

Conclusion: The study shows that average reading speed in a presbyopic population was improved when corrected with multifocal compared to single vision CLs. Moreover, average reading speed was faster with binocular compared to monocular viewing. Eye fixation analysis showed that fixation duration was the only parameter improved in both conditions, while no difference was found for the number of fixations and regressions, which are known to be affected in macula disease and by cognitive factors. Evaluating reading performance using eye fixation analysis can result in a reliable outcome of functional vision in presbyopia correction.

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