

Implementing eye movement-based reading performance as a measure of functional vision in presbyopes

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Purpose: Simple measures of acuity provide only a partial indication of functional vision of in presbyopia correction. Many complaints from presbyopes originate in reading difficulties, especially under low lighting levels. Here we present a new method, based on eye movement analysis, to evaluate sustained reading performance in a presbyopic population.

Methods: Eighteen volunteers (age 64 ± 4 yrs) with normal vision participated in the study. Reading performance was evaluated binocularly and monocularly (dominant eye) using simple paragraphs of about 140 words each (0.4 logMAR print size at 40 cm distance) at two luminance levels (50 and 5 cd/m²). A reading comprehension questionnaire was performed to secure a high level of attention. Eye movements were monitored with an infrared eyetracker (Eye-Link II, SR Research Ltd). Data analysis included computation of reading speed (in wpm), fixation duration, number of fixations per word and percentage of regressions.

Results: Average reading speed was 198 ± 44 and 183 ± 43 wpm binocularly and monocularly, respectively. The binocular advantage was statistically significant ($p=0.04$) and was attributed to the faster average fixation duration with binocular (236 ± 36 ms) compared to monocular (251 ± 40 ms) viewing ($p=0.011$). Number of fixations per word (0.9 ± 0.2 vs 0.9 ± 0.2 , $p=0.41$) and percentage of regressions (14 ± 5 vs. 13 ± 5 , $p=0.22$) did not differ between the two viewing conditions. Reading speed with binocular viewing was dramatically decreased in low luminance to 128 ± 57 wpm ($p<0.001$). This was mainly due to an increase in average fixation duration by 145ms (381 ± 88 ms, $p<0.001$), while number of fixations increased to 1.0 ± 0.3 fpw ($p=0.02$). Percentage of regressions was not altered in low luminance (14 ± 6 , $p=0.94$).

Conclusion: The study shows that average fixation duration is the main eye movement parameter influenced when visuomotor processing is altered - fixations and regressions are mostly affected in retina disease and by cognitive factors. Evaluating reading performance using eye fixation analysis can result in a reliable outcome of functional vision in presbyopia correction.