

Reading performance revisited using eye fixation analysis: reading aloud or silent?

Plainis S¹, Ktistakis E¹, Gleni A¹, Simos P, Tsilimbaris MK^{1,2}

¹Laboratory of Optics and Vision, School of Medicine, University of Crete, Heraklion, Greece

²Ophthalmology Department, University Hospital of Heraklion, Heraklion, Greece

³Institute of Computer Science, Foundation of Research and Technology-Hellas, Heraklion, Greece

AIM: Reading is of fundamental importance in modern culture and it forms a strong predictor of vision-related quality of life since many activities of daily living rely on its function. Although a number of standardized reading texts are available nowadays, reading performance measures are not yet fully implemented in the clinical practice, because of their significant test-retest and inter-individual variability, as a result of the high influence of cognitive factors. The objective of this work is to present a new method based on eye movement analysis which can improve reading speed variability in silent reading.

METHODS The reading performance of nineteen volunteers (average age 27 yrs, range: 22-36 yrs) was evaluated using two IReST texts of 0.4 logMAR print size at 40cm distance. First, participants read the texts aloud and as fast as they could. Second, participants read the texts silently while their eye movements were monitored using an infrared eye-tracker. Data analysis included computation of reading speed, the number of fixations per word, fixation duration, and percentage of regressions. Frequency distributions of fixations durations were further analysed with an ex-Gaussian fitting, a convolution of a normal and exponential distribution, with μ and τ parameters characterizing its location and shape, respectively.

RESULTS: Average reading speed was 204 (± 17) and 229 (± 45) wpm for the aloud and the silent reading respectively ($p=0.012$). The repeatability coefficient ($2*SD$) was better in the aloud (27 wpm) compared to the silent (47 wpm) condition. In the silent condition, average number of forward fixations was 0.90 (± 0.10) fpw, and the repeatability coefficient 0.14 fpw. Average fixation duration was 200ms (± 20) and the repeatability coefficient 21ms. Average percentage of regressions was 14.0% (± 6.1) and the repeatability coefficient 6.9%. Reading speed was significantly correlated to the number of fixations ($r=-0.83$) and fixation duration ($r=-0.75$).

CONCLUSIONS: Most of the variability in silent reading speed derives from the number of fixations, which is known to depend on cognitive factors. Reading speed variability is better in aloud compared to silent / comprehensive reading, but does not reflect real conditions, while is limited by articulation speed. Repeatability in silent reading is significantly improved using fixation-based analysis, resulting in a more reliable outcome of reading behaviour.