THE EFFECT OF DIOPTRIC BLUR ON READING PERFORMANCE MONOCULAR vs. BINOCULAR NEAR VISION

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1. Background

Reading is often used as a surrogate measure for other activities of daily living, which are less easily measured, and characterises functional vision (1). Although the effect of uncorrected refractive error (2) or induced blur (3) on spatial vision, i.e. letter acuity and contrast sensitivity, is well established, little is known about the systematic impact of blur on reading performance (4). The purpose of this study was to investigate the effect of dioptric blur on reading performance, in a group of normally sighted presbyopes.

2. Methods

Sixteen healthy presbyopes (mean age: 59 ± 8 years; mean addition: 2.21±0.34 D) participated in the study. Reading performance was evaluated using three versions of high-contrast Colenbrander cards (5) in Greek language (Precision Vision, US).

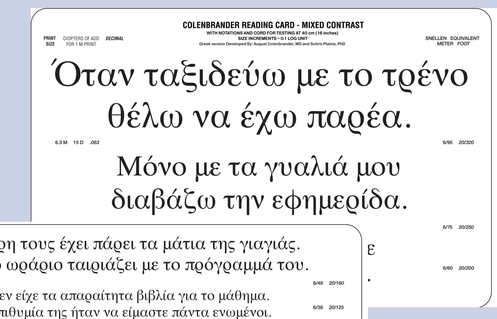
Monocular (dominant eye) and binocular measurements were performed at 40cm distance at three conditions:

i. In focus: Wearing best spectacle sphero-cylindrical correction for near (40m cm).
ii. 0.50 D blur: induced by negative lenses over the best near correction (corresponding to 0.50D under-correction for near)
iii. 1.00 D blur: induced by negative lenses over the best near correction (corresponding to 1.00D under-correction for near)

For each condition, participants read aloud sentences on one of these charts, from large to small print. Reading time for each sentence was recorded and converted to:

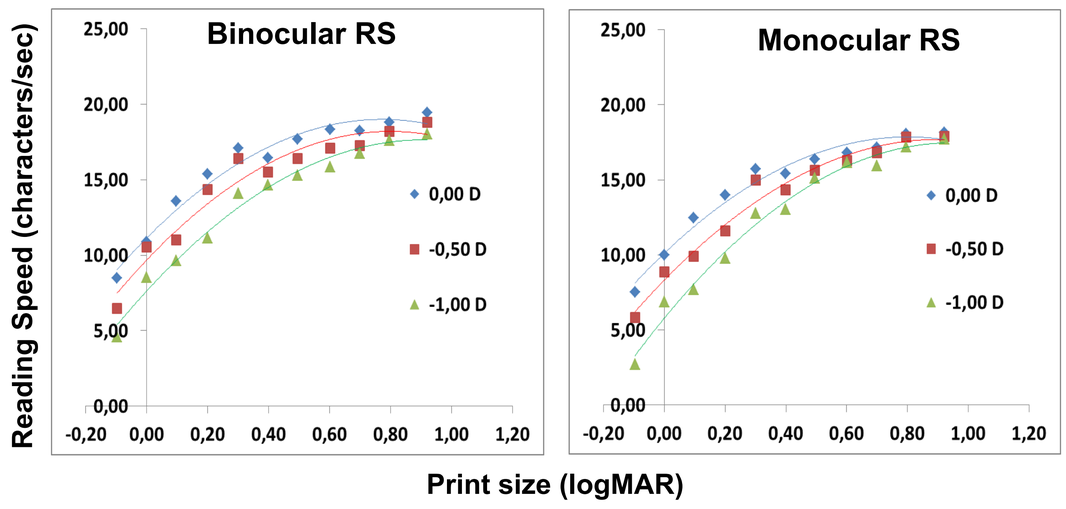
i. Reading acuity: the smallest print in logMAR that the participant can read
ii. Maximum reading speed: the participant's reading speed when reading is not limited by print size
iii. Threshold print size: the print size that corresponds to an 80% of the maximum reading speed and
iv. "Newsprint" reading speed: the participant's reading speed at 0.4 logMAR (average newsprint) print size.

Measurements were counterbalanced. Pupil size (under binocular viewing) was measured with an infrared camera. General Linear Model, ANOVA and post hoc analysis Bonferoni were performed using IBM SPSS Statistics 19.



High-contrast Colenbrander continuous reading cards in Greek language (Precision Vision, LaSalle, USA). The segments in the card are of equal length.

3. Reading Speed as a function of letter print size

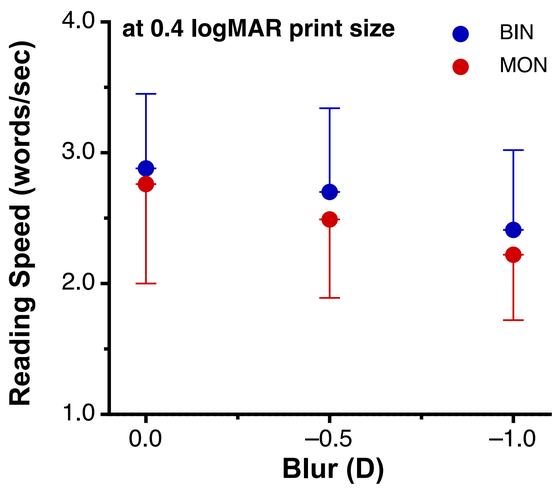


Reading Speed remains fairly constant for large print sizes, gradually decreasing as print size was getting smaller.
Maximum Reading Speed is minimally affected by blur (p=0.19). No difference between binocular and monocular reading exists (p=0.50)

4. "Newsprint" Reading Speed

Newsprint Reading Speed was significantly affected by dioptric blur (**p=0.007**)

No statistically significance difference between binocular and monocular vision was found (p=0.16)

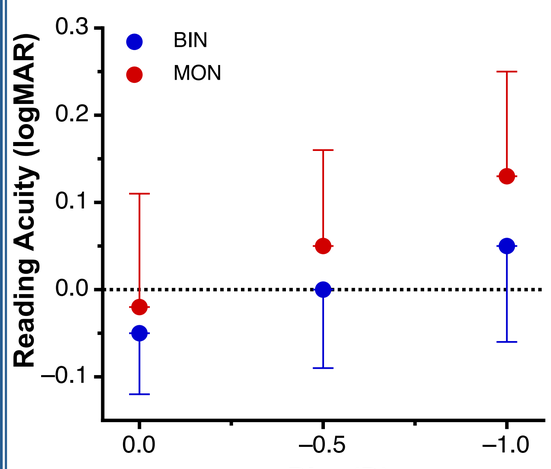


Binocular vision:
in-focus to -0.50 D blur: 0.18 w/s (p=0.11)
-0.50 to -1.00 D: 0.29 w/s **(p=0.001)**
in-focus to -1.00 D: 0.47 w/s **(p<0.001)**

Monocular vision:
in-focus to -0.50 D blur: 0.27 w/s (p=0.12)
-0.50 to -1.00 D: 0.27 w/s (p=0.11)
in-focus to -1.00 D: 0.54 w/s (**p=0.01**)

5. Reading Acuity

There was a significant difference in Reading Acuity:
- ✓ with dioptric blur (**p<0.001**)
- ✓ between binocular – monocular vision (**p=0.008**)

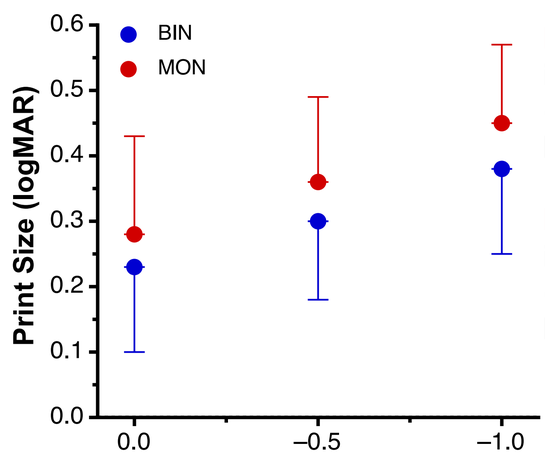


Binocular vision:
in-focus vs. -0.50 D blur: 0.05 logMAR (p=0.45)
-0.50 vs. -1.00 D: 0.05 logMAR (p=0.31)
In-focus vs. -1.00 D: 0.10 logMAR (**p=0.004**)

Monocular vision:
in-focus vs. -0.50 D blur: 0.07 logMAR (p=0.15)
-0.50 vs. -1.00 D: 0.08 logMAR (p=0.12)
In-focus vs. -1.00 D: 0.15 logMAR (**p<0.001**)

6. Threshold Print Size

Threshold Print Size was significantly affected:
- ✓ with dioptric blur (**p<0.001**)
- ✓ between binocular – monocular vision (**p=0.02**)



Binocular vision:
in-focus to -0.50 D blur: 0.07 logMAR (p=0.42)
-0.50 to -1.00 D: 0.08 logMAR (p=0.20)
In-focus to -1.00 D: 0.15 logMAR (**p=0.004**)

Monocular vision:
in-focus to -0.50 D blur: 0.08 logMAR (p=0.29)
-0.50 to -1.00 D: 0.09 logMAR (p=0.32)
In-focus to -1.00 D: 0.17 logMAR (**p=0.005**)

8. Conclusions

Defocus blur (corresponding to under-correction for near vision) adversely affects reading performance:
- ➢ Reading Acuity is adversely influenced
- ➢ Threshold Print Size is increased in order to have comfortable reading
- ➢ Reading Speed for "newspaper" letter print is reduced

These effects reach statistical significant level for amounts optical blur > 0.50D.

Binocular vision ameliorates the effect of blur on reading performance.

Preliminary analysis shows that the effects of blur on reading acuity and threshold print size are also influenced by the amount of addition needed for each participant but not by his pupil size.

9. References

1. Colenbrander A. (2010). Introduction to visual acuity measurement. Precision Vision.
2. Atchison D. A., Smith G. & Efron E. (1979). The effect of pupil size on visual acuity in uncorrected and corrected myopia. American Journal of Optometry & Physiological Optics, 56, 315–323.
3. Bedell H. E., Patel S. & Chung S. T. L. (1999). Comparison of letter and vernier acuities with dioptric and diffusive blur. Optometry and Vision Science, 76, 115–120.
4. Chung S., Jarvis S., Cheung S. (2007) The effect of dioptric blur on reading performance. Vision Research 47 (2007) 1584–1594
5. Precision Vision (www.precision-vision.com)

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