The effect of object size on blur perception

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Introduction

Studies of blur perception and sensitivity are relevant to fundamental visual perception. Blur perception has an effect on visual acuity, accommodation control, the results of optometric examination, and adaption to various designs of ophthalmic lenses. [1]

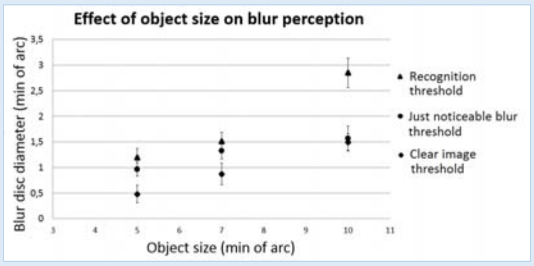
It is possible to produce defocus in two ways – by using source or observer methods (quality of a target image is degraded or observer retinal image can be defocused by use of optical systems). Both methods can be used in studies of blur perception and the results are comparable, although source method (which was used in this study) has several advantages over observer method. [1, 2, 3]

Our aim was to compare the effects of target size and the initial blur level on the recognition visual acuity and the blur sensitivity using source blurring method. After first stage of our study we continued measurements with more aspects of blur sensitivity evaluation and two groups of subjects – myopes and emmetropes.

Methods of stage 1

- 6 participants
- Best spherocylindrical correction (V.A.at least 0.0 log MAR)
- Targets: 3 different size optotypes (E letter): 5 min. of arc., 7 min. of arc., 10 min. of arc
- Blur simulation – source method, Gaussian low-pass spatial frequency filter
- Image quality judgments:
    - Blur level increases from ideally sharp image position:
        - Just noticeable blur in image
    - Blur level decreases from maximal level (image looked like blurry spot):
        - Participant recognizes the optotype (Recognition threshold)
        - Participant perceives image as clear and sharp (Clear image threshold)

Results of stage 1



The thresholds for all 3 blur perception aspects increase, as the size of the optotype increases. The effect of specific blur disc diameter reduces as the optotype becomes larger. Results is consistent with the findings of other researchers. [1,3,4]

The difference between recognition threshold and clear image threshold increased almost twice as the size of the target increased from 5 min. of arc to 10 min. of arc, while the difference between just noticeable blur and clear image threshold decreased to minimum value.

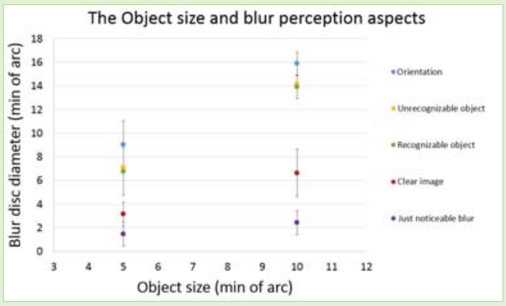
Conclusions

- Gaussian low-pass filter can be used to simulate defocus in blur perception measurements.
- The difference between the optotype recognition threshold and the clear image perception threshold increases as a stimulus size increases.
- We did not find a statistically significant difference in blur perception thresholds between myope and emmetrope groups.
- Blur tolerance for all blur perception aspects increased after the adaptation to optical blur (simulated myopia, 30 min).

Methods of stage 2

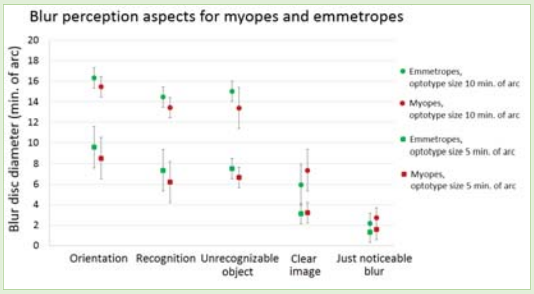
- 18 participants (9 myopes, 9 emmetropes)
- Best spherocylindrical correction (V.A. At least 0.0 log MAR)
- Targets: 2 different size optotypes (Landolt C in 4 orientations): 5 min. of arc, 10 min. of arc
- Blur simulation – Gaussian low-pass spatial frequency filter
- Image quality judgments:
    - Blur level increases:
        - Just noticeable blur
        - Participant can not recognize the optotype (Unrecognizable object)
    - Blur level decreases:
        - Participant recognizes the orientation of the object (Orientation)
        - Participant recognizes the optotype (Recognizable object)
        - Participant perceives image as clear and sharp (Clear image)

Results of stage 2

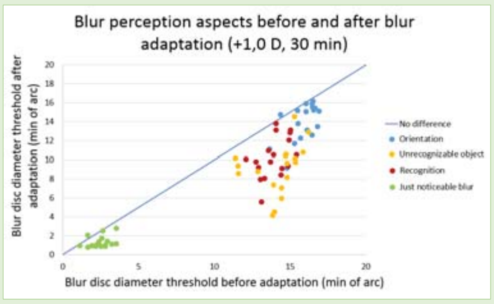


Difference between clear image/just noticeable blur threshold and orientation/recognition threshold increased as object size increased.

Contrary to previous stage of experiment – just noticeable blur threshold was detected as lower than clear image perception threshold for this group of subjects.



Difference between refraction groups was not statistically significant, but mean thresholds for emmetropes were higher than for myopes at orientation and recognizable/unrecognizable object blur perception aspects. However mean thresholds for myopes were higher at clear image/just noticeable blur aspects.



After 30 min adaptation to optically simulated myopia of 1.0 D thresholds for all blur perception aspects increased. Blue line demonstrates no change position. Data points shows measurements of all participants with 10 min. of arc optotype. Clear image thresholds are not shown because none of emmetrope group described image as clear after optical blur simulation.

References

[1] Jacobs RJ, Smith G & Chan CDC. Effect of defocus on blur thresholds and on thresholds of perceived change in blur: comparison of source and observer methods. *Optom Vis Sci.* 1989; **66**:545-553.
[2] Dehnert A, Bach M & Heinrich SP Subjective visual acuity with simulated defocus. *Ophthalmic Physiol Opt.* 2011; **31**:625-631.
[3] Smith G, Jacobs RJ & Chan CDC. Effect of defocus on visual acuity as measured by source and observer methods. *Optom Vis Sci.* 1989; **66**:430-435.
[4] Legge GE, Mullen KT, Woo GC & Campbell FW. Tolerance to visual defocus. *J. Opt.Soc.Am.A* 1987; **4**:851-863.

Acknowledgements
Supported by: ESF Nr. 2013/0021/1DP/1.1.1.2.0/13/APIA/VIAA/001

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