Influence of pursuit velocity on the enhancement of chromatic sensitivity during smooth pursuit

Alexander C. Schütz[1], Doris I. Braun[1], Dirk Kerzel[2] & Karl R. Gegenfurtner[1]

Justus-Liebig-Universität Gießen[1] & Université de Genève[2]

Contact: alexander.c.schuetz@psychol.uni-giessen.de

Introduction & Methods

Movements of the eyes do have negative effects on visual perception. During saccadic eye movements, for example, suppression has been reported for luminance stimuli with low spatial frequency. As such stimuli are processed in the magnocellular system, it has been concluded that the magnocellular system is actively suppressed during saccades[1]. Sensitivity for chromatic stimuli and high-spatial frequency luminance stimuli is spared from this suppression. For smooth pursuit eye movements, we showed recently that the sensitivity for peripheral luminance stimuli is suppressed, probably due to the binding of spatial attention to the pursuit target[2]. Here we investigate the sensitivity for chromatic stimuli.

We measured the sensitivity for color and luminance stimuli during pursuit and fixation. Subjects had to track a spot target that was stationary (fixation) or moved horizontally (pursuit) with a velocity of 10.5 deg/s. Contrast sensitivity was measured by means of a blurred 0.3 deg wide horizontal line that appeared for 10 ms 2 deg above or below the pursuit trajectory. The line was defined by an increment or decrement in luminance or in isoluminant red-green color.

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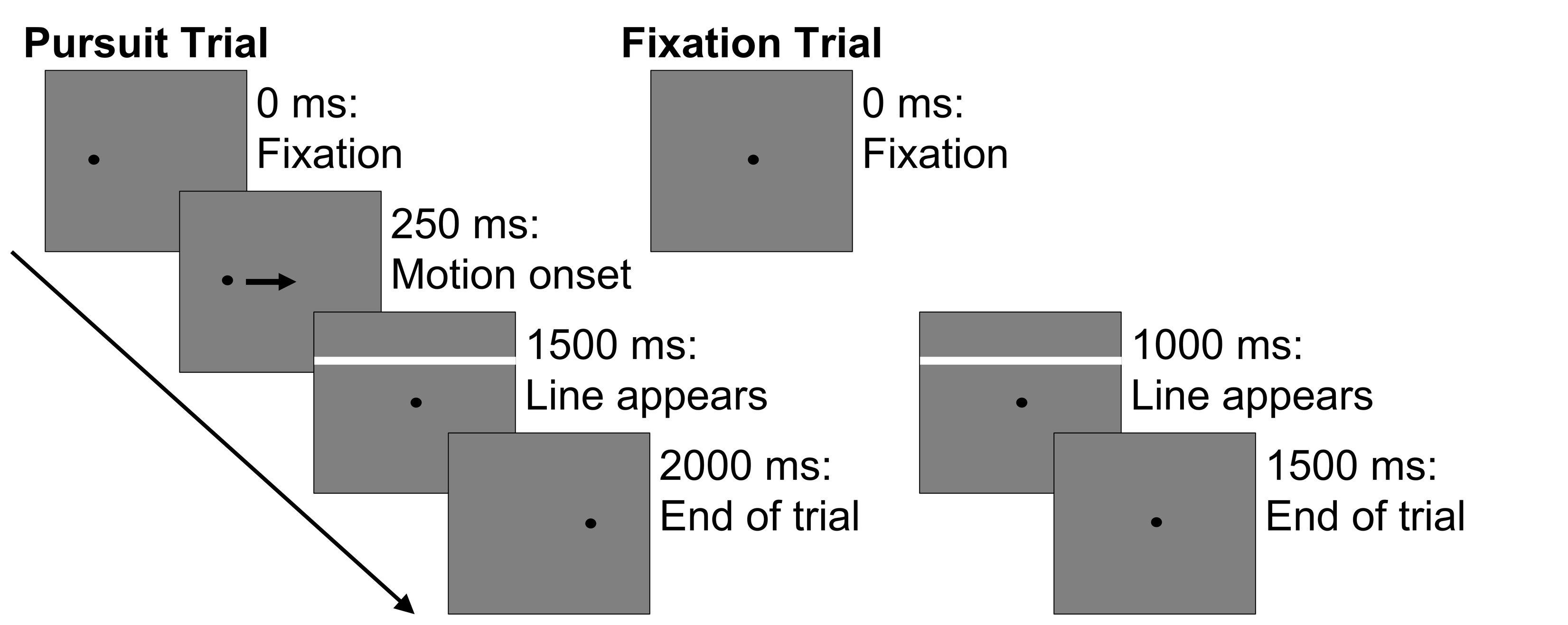


References:

[1] Burr, D.C., Morrone, M.C. & Ross, J. Selective suppression of the magnocellular pathway during saccadic eye movements. *Nature* 371, 511-513 (1994).

[2] Schütz, A.C., Delipetkos, E., Braun, D.I., Kerzel, D., & Gegenfurtner, K.R. Temporal contrast sensitivity during smooth pursuit eye movements. *Journal of Vision*, 7(13):3, 1-15 (2007).

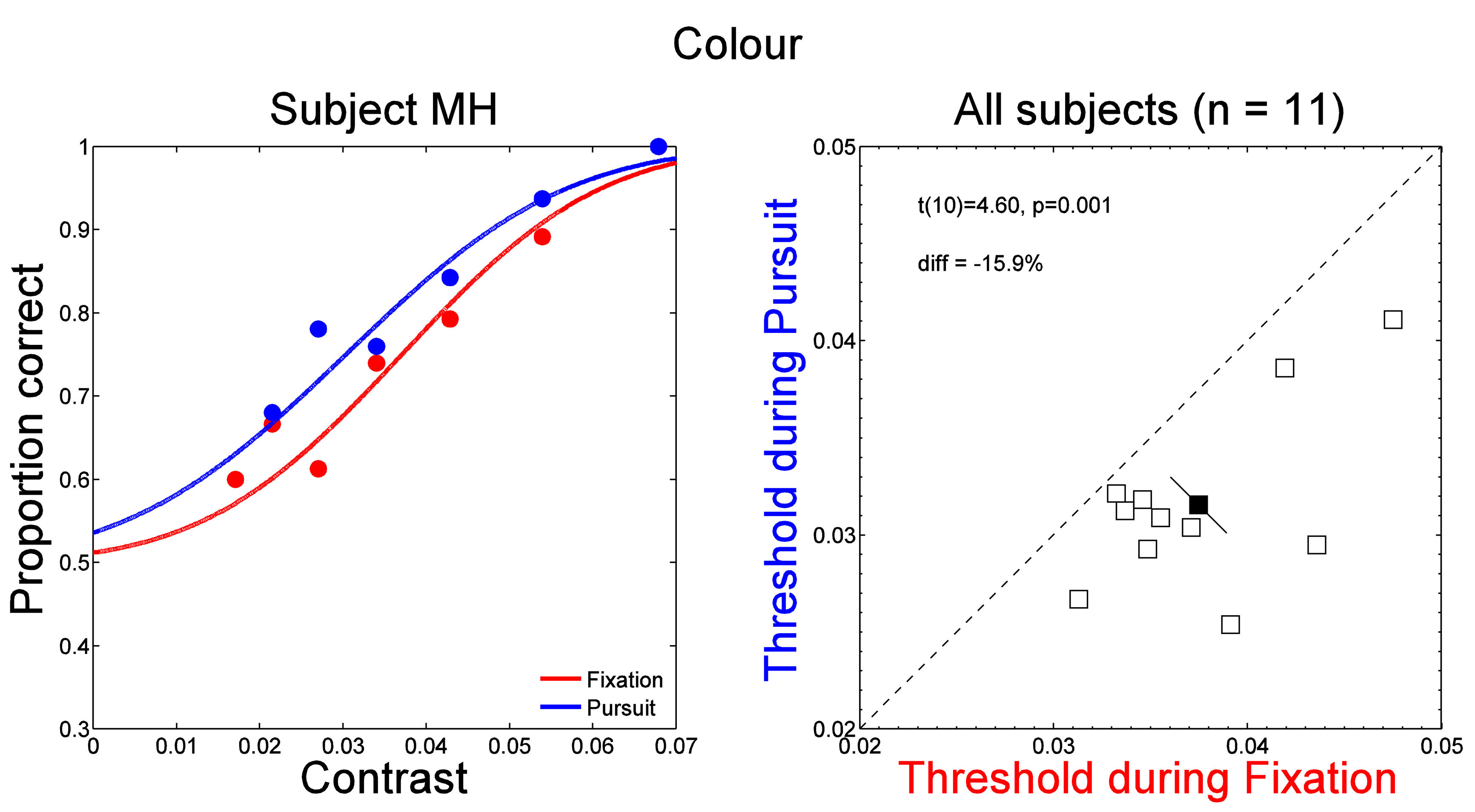
[3] Schütz, A.C., Braun, D.I., & Gegenfurtner, K.R. Contrast sensitivity during the initiation of smooth pursuit eye movements. *Vision Research*, 47, 2767-2677 (2007).

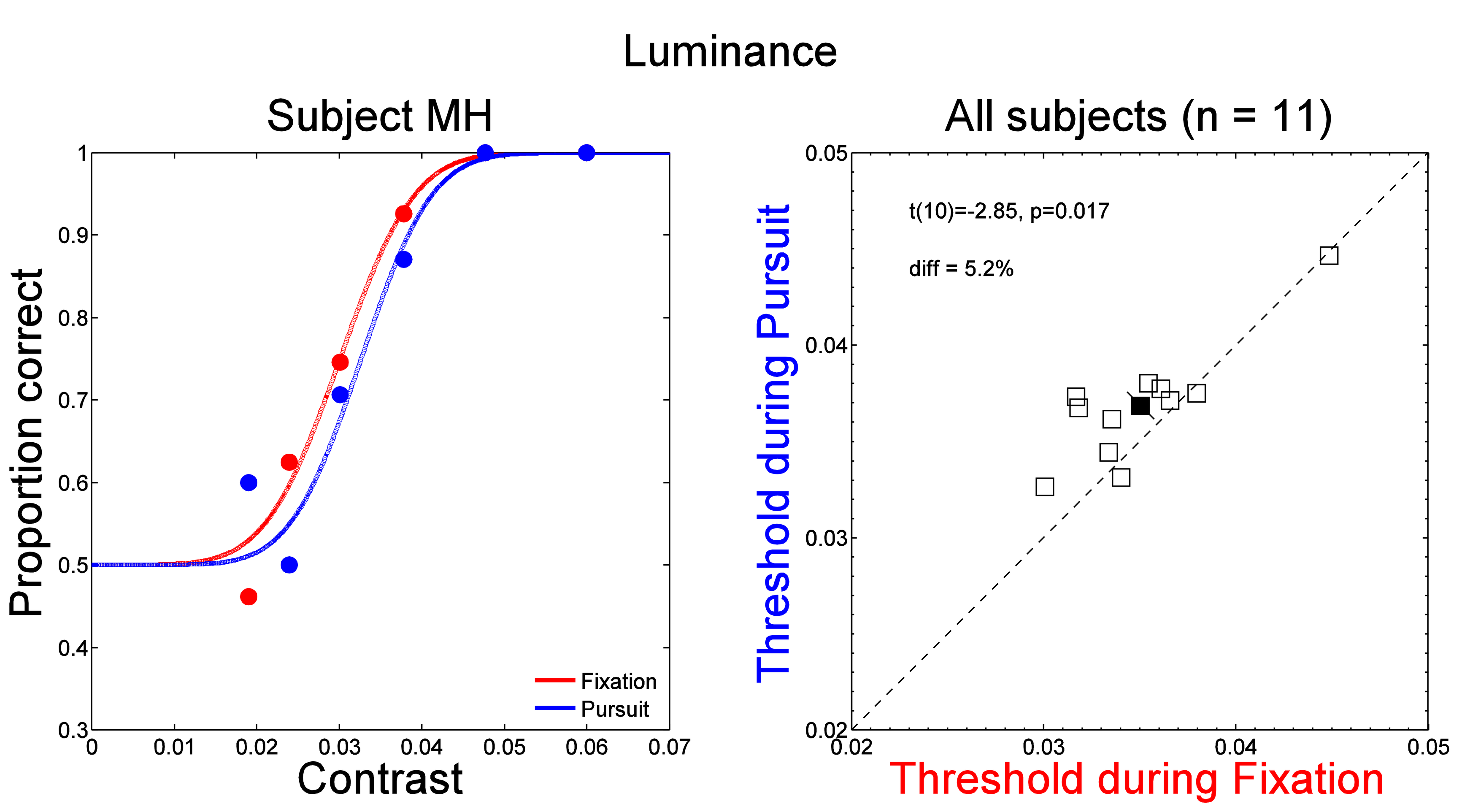
Results & Conclusions

1. Low Spatial Frequencies

Methods: We measured peripheral sensitivity for chromatic and achromatic stimuli during fixation and smooth pursuit.

Results: The detection thresholds for chromatic stimuli (top) were lowered during smooth pursuit on average by **16%** compared to fixation. For achromatic stimuli (bottom) in contrast the thresholds were on average **5%** higher during pursuit than during fixation. Colour naming thresholds followed the same pattern.

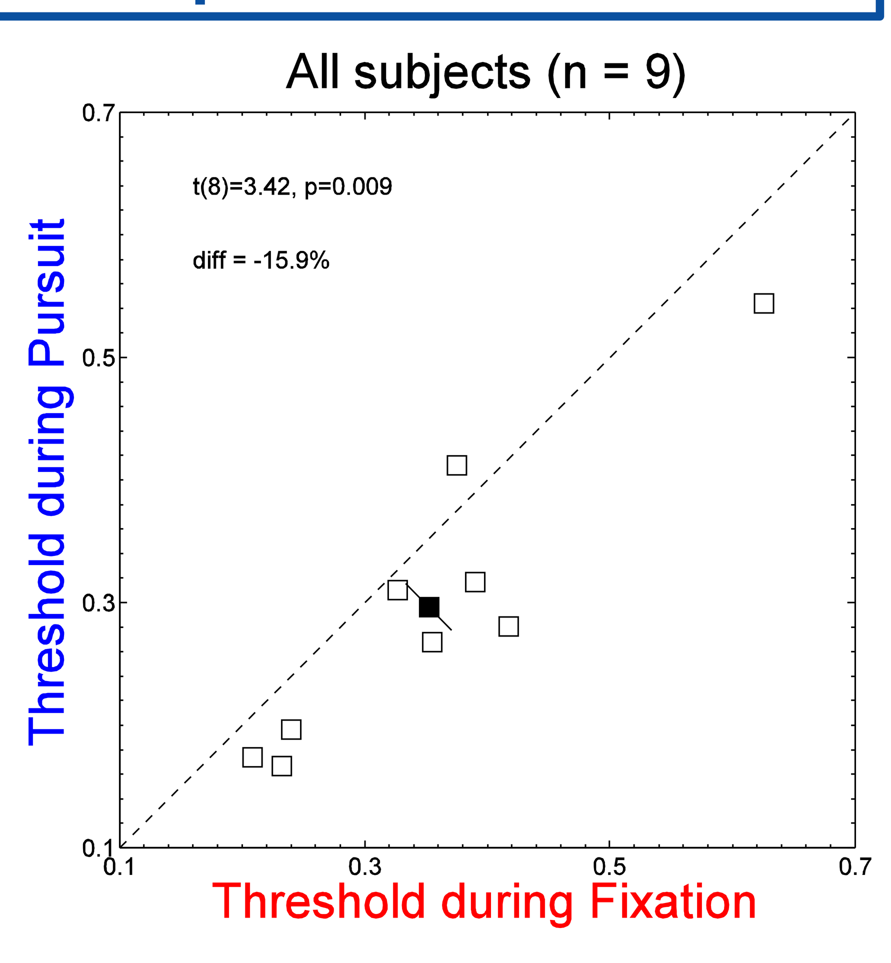




2. High Spatial Frequencies

Methods: To investigate if the improvement is specific for the parvocellular pathway, we measured foveal sensitivity for an achromatic square wave pattern with a spatial frequency of 14 cpd.

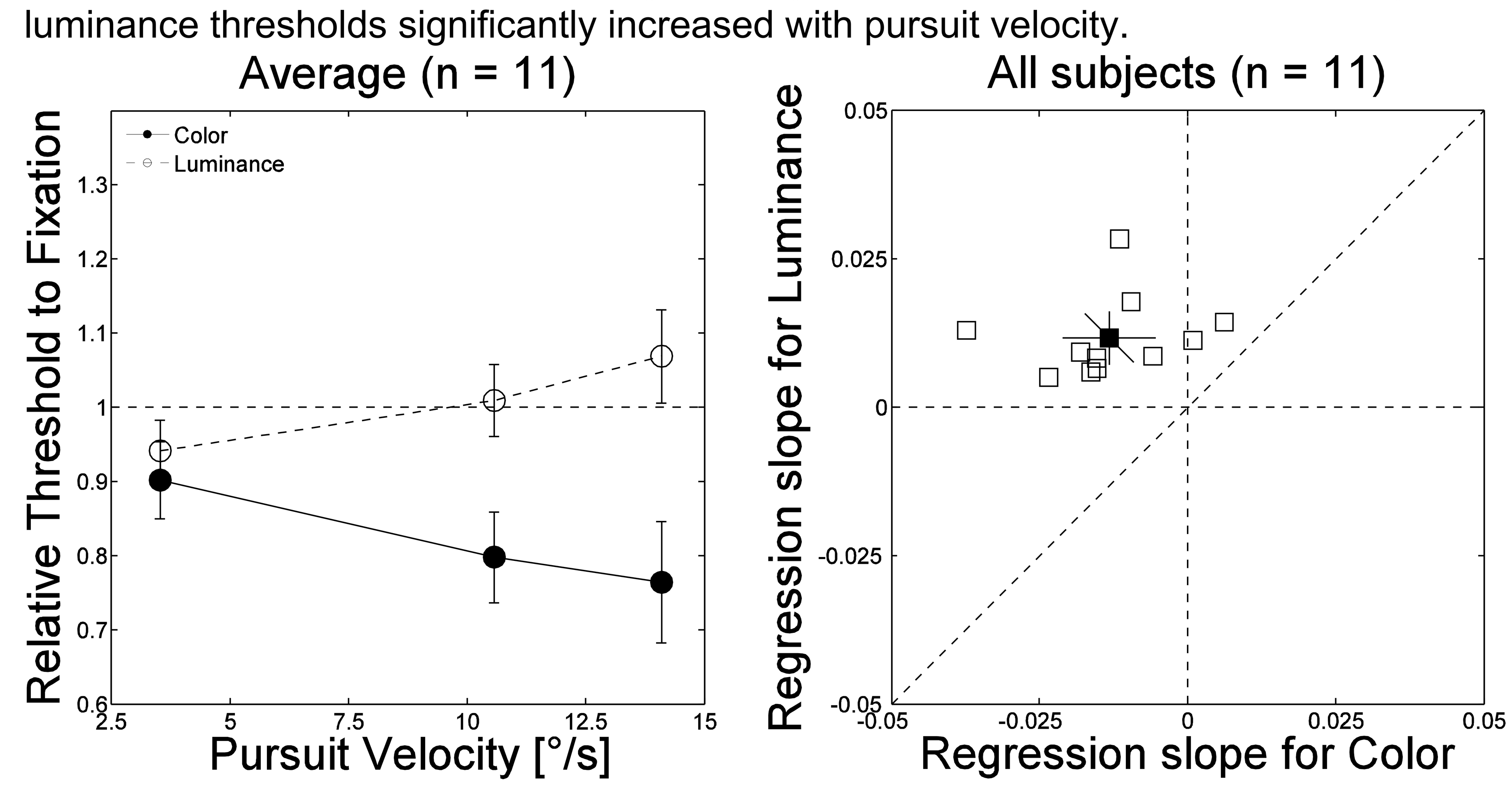
Results: For these stimuli we also obtained a **16%** improvement during smooth pursuit compared to fixation. As the sensitivity improvement occurs for color stimuli and for stimuli with high spatial frequencies, we conclude that the parvocellular pathway is selectively enhanced during smooth pursuit eye movements.



3. Pursuit Velocity

Methods: We measured chromatic and luminance sensitivity during fixation and three different pursuit velocities: 3.5, 10.5 and 14 deg/sec. We normalized the thresholds for each subject separately to the threshold during fixation. Next we fitted for every subject a regression line for chromatic thresholds and a regression line for luminance thresholds.

Results: Chromatic thresholds significantly decreased with pursuit velocity and luminance thresholds significantly increased with pursuit velocity.



4. Pursuit Initiation

Methods: Here we flashed a horizontal red line with a fixed contrast at different times relative to the onset of a step-ramp target. By means of a sliding weighted histogram we calculated the detection rate over the time course of pursuit initiation[3].

Results: The detection rate increased approximately **100 ms after target onset** and approximately **50 ms before smooth pursuit onset**. As the enhancement preceded the eye movement, an extra-retinal signal has to trigger the sensitivity enhancement.