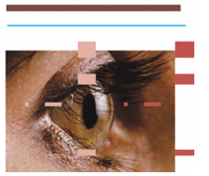
Chromatic Sensitivity is improved during Smooth Pursuit Eye Movements

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

Justus-Liebig-University Giessen[1] & Université de Genève[2]

Contact: gegenfurtner@uni-giessen.de

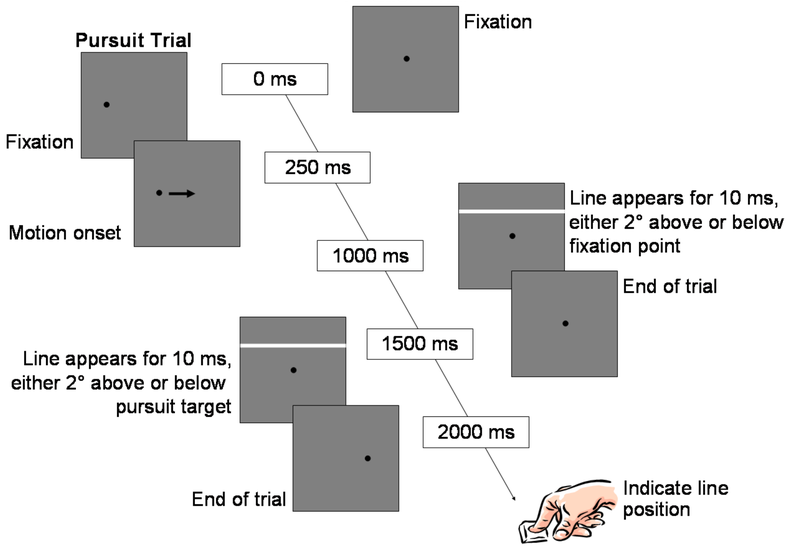


Introduction

Movements of the eyes do have negative effects on visual perception. During saccadic eye movements, for example, suppression has been reported for stimuli being processed in the magnocellular system[1], while at the same time the visual world is compressed towards the saccade target[2]. We explored the possibility that similar effects would surface during smooth pursuit eye movements. Thus we investigated how smooth pursuit affects the sensitivity for color and luminance stimuli.

Methods

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 10.57 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. A staircase procedure was used to find the contrast level at which the subjects could either just tell whether the line was presented above or below the pursuit target, or at which they could just indicate whether the line appeared black, white, red or green.



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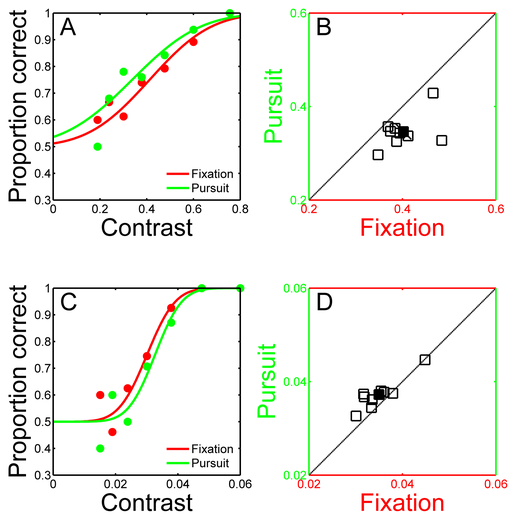
Results

Main Experiment

The threshold for chromatic stimuli (A & B) was lowered during smooth pursuit by 13% compared to fixation. For achromatic stimuli (C & D) in contrast the thresholds were on average 6% higher during pursuit than during fixation.

The enhancement.for chromatic stimuli and the attenuation for achromatic stimuli during pursuit were observed during the detection task as well as during the colour naming task.

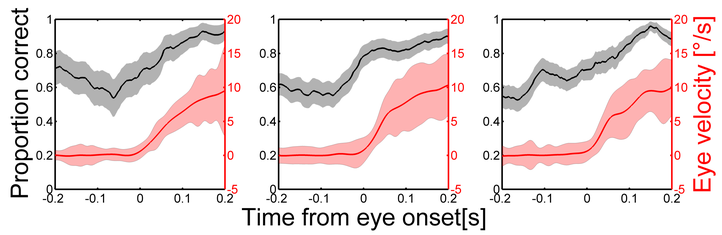


Pursuit Initiation

Introduction: In a this experiment we wanted to explore the starting point of the sensitivity enhancement. Therefore we investigated the sensitivity for color stimuli during pursuit initiation.

Methods: Here we flashed a horizontal red line with a fixed contrast at different points in time 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 results show an increase of the detection rate even before the onset of smooth pursuit. This indicates an extra-retinal source of the sensitivity enhancement.

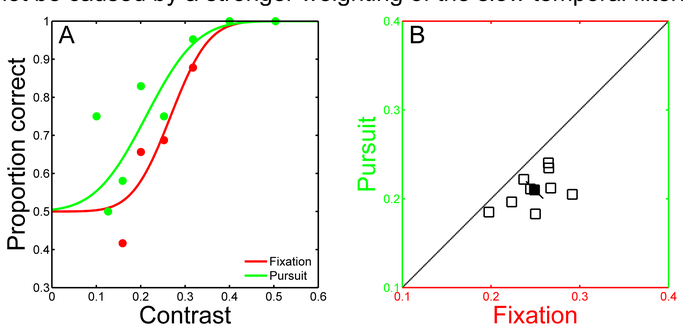


High Temporal Frequency

Introduction: In this experiment we wanted to test, if the enhancement for chromatic stimuli applies only for low temporal frequencies. It has been shown, that the human visual system contains at least two independent filters[4]. As the slow filter is especially sensitive for color, the enhancement for color stimuli during pursuit could be caused by an enhanced sensitivity of this slow filter.

Methods: To test the sensitivity for high temporal frequencies, we flickered the line in red-green with a temporal frequency of 16 Hz for 120 ms. This stimulus certainly activates the fast temporal filter.

Results: The results show a 15% enhanced sensitivity during pursuit also for this high temporal frequency. Therefore the enhancement cannot be caused by a stronger weighting of the slow temporal filter.



Foveal Detection

Introduction: Here we investigated, if the sensitivity enhancement for peripheral stimuli generalizes to foveal stimuli. For achromatic stimuli it has been shown that the reduced sensitivity only occurs for peripheral targets[5,6].

Methods: Here we flashed red and green lines behind the pursuit target on the horizontal median. The subjects had to indicate the color of the line at the end of each trial.

Results: The results show that there is also a sensitivity enhancement for foveally presented chromatic stimuli during pursuit. This rules out any explanations which refer to space-based attention.