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Evaluation of Smooth Pursuit in Individuals with Central Field Loss

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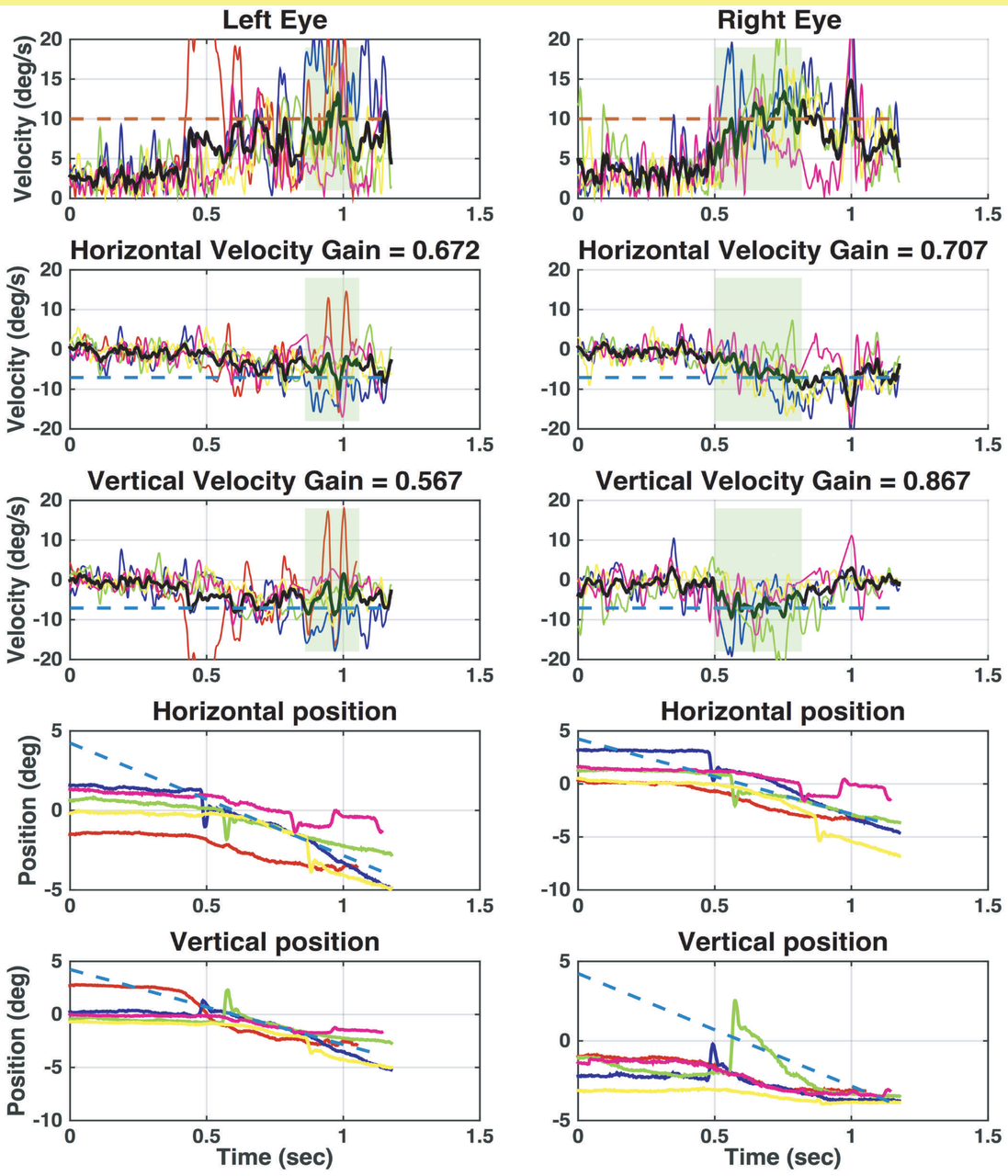
Introduction

- Smooth pursuit eye movements are traditionally tied to the fovea.
- Little is known about pursuit with central field loss (CFL).
- CFL is often associated with the loss of the fovea, eccentric viewing, & loss of binocular vision.

Methods

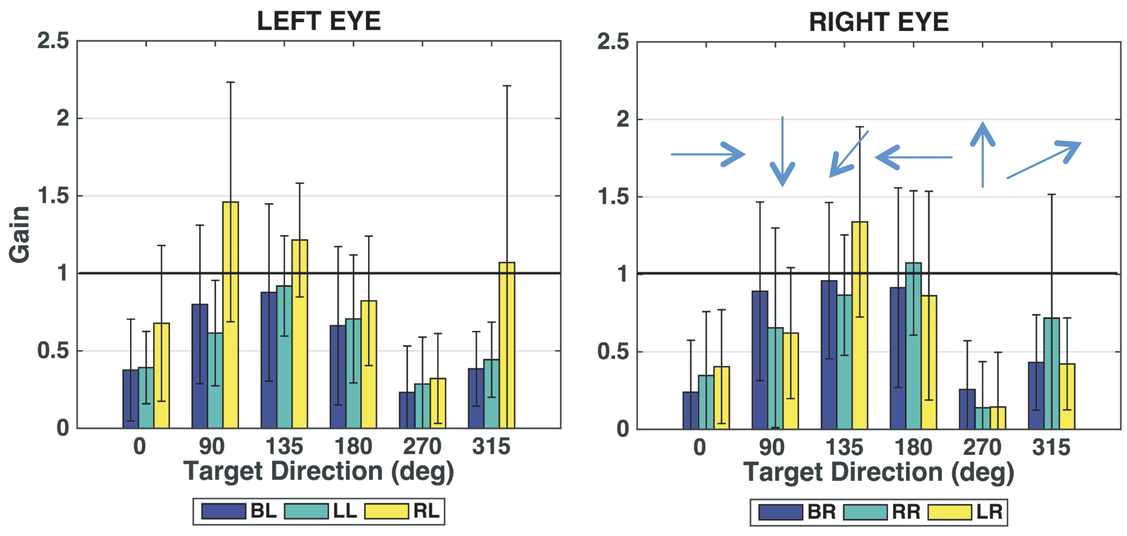
- Participants: 7 CFL patients, ages 57-91; 2 Controls, ages: 70, 85.
- Task: pursuit of a 1° spot, step ramp paradigm (Rashbass 1961)
  - 6 directions (0°, 90°, 135°, 180°, 270°, 315°) at 5, 10 & 15 °/s.
- Experiments repeated with binocular & monocular viewing
- Eye movements of both eyes were always recorded (EyeLink).
- Velocity gains & error (deviation of eye position from the target direction) were used to quantify pursuit.

1 Eye Velocity & Postion During Binocular Smooth Pursuit of a 10°/s Target



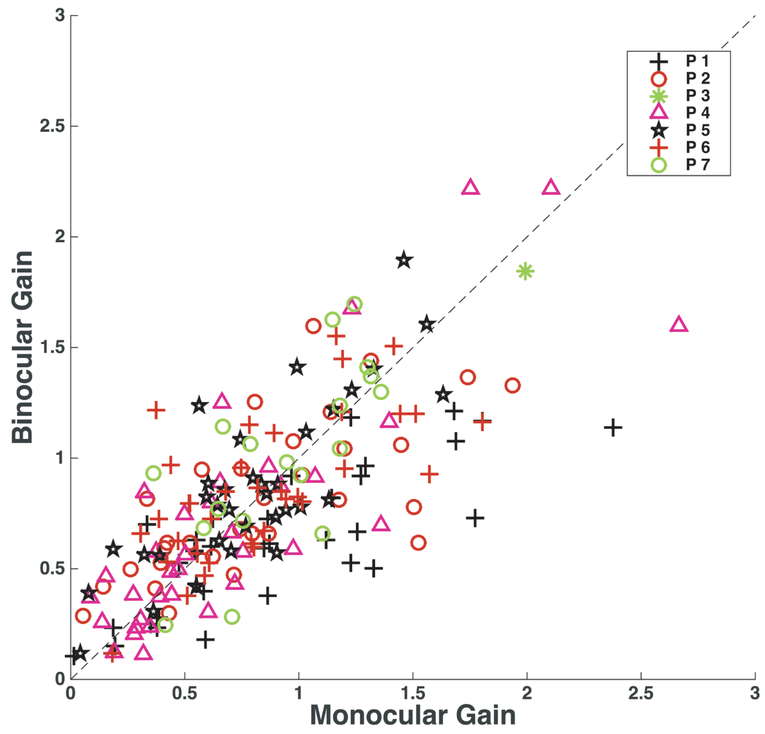
Example velocity & position traces (patient P1). Dashed blue line: target; thick black line: average eye velocity. Different colors denote individual trials.

2 Gain Varies Across Trajectories for Binocular & Monocular Pursuit



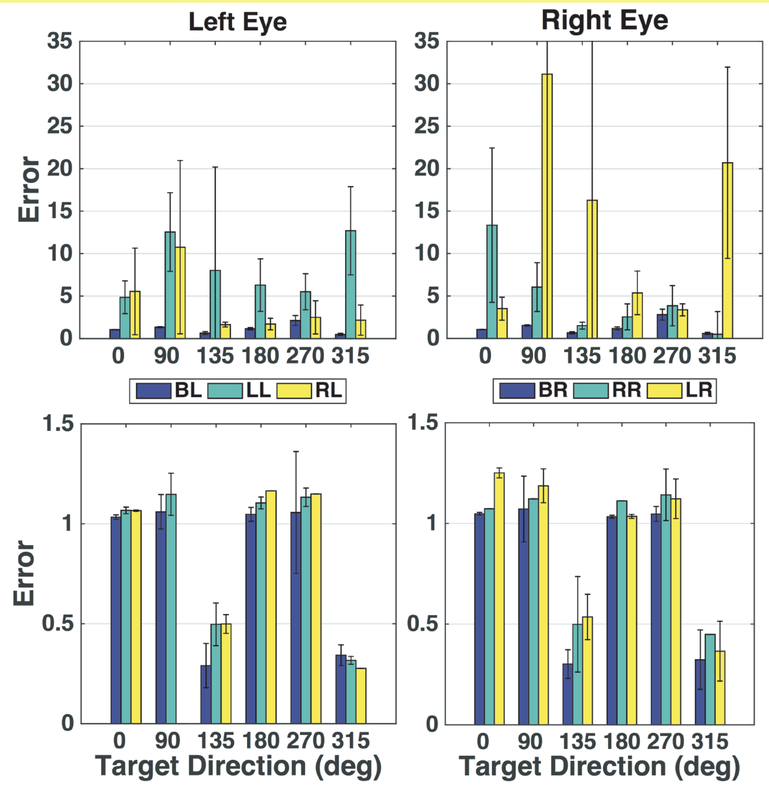
Summary of average gains of 10°/s trials, for all directions for patient in Figure 1. Gains vary across directions, consistent with the patient's scotoma location (upper right visual field) and are similar for binocular & monocular pursuit with the viewing and non-viewing eyes. Left pane: data recorded from the left eye: right pane: right eye. First legend letter: viewing condition (Both, Left, Right Eyes).

3 Gain Does Not Improve in Binocular vs. Monocular Pursuit



Binocular pursuit gain versus monocular pursuit gain of the corresponding viewing eye. There was no difference in pursuit gains for patients or controls (Mann-Whitney U Test, $p>0.2$). Symbols represent individual patients, black dashed line: identity line. Gains for all velocities and directions are plotted.

4 Position Errors for Patient and Control Pursuit Targets at 5°/s

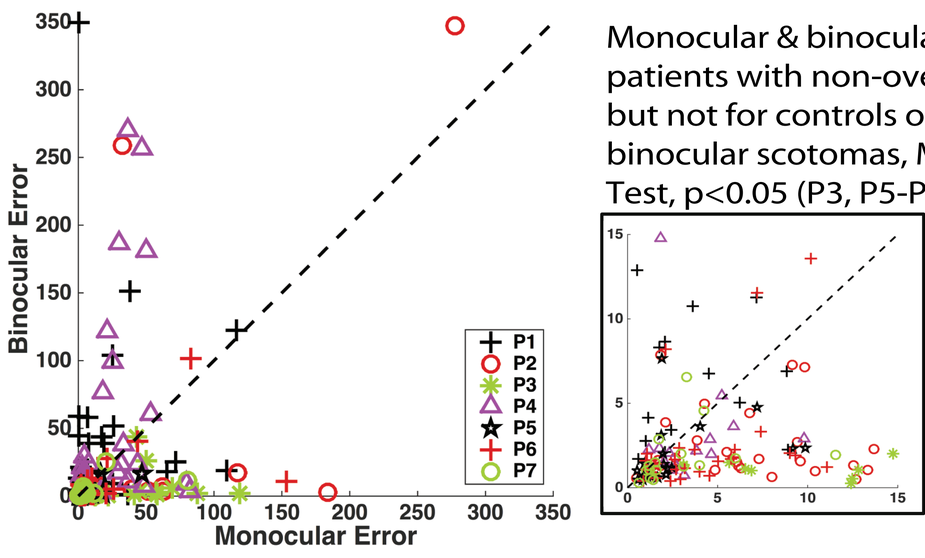


Top row: position errors for a patient (P6) with non-overlapping scotomas. Error is greatest for the non-viewing right eye and is lowest during binocular pursuit. Bottom row: position errors for a control participant. Errors are comparable across viewing conditions and significantly lower than the patient's (note difference in y-axis scales).

To compute error, position data were fit with a line of the the same slope as the target and

$$Error = \frac{SS_{resid}}{SS_{tot}}$$

5 Position Error Differs Between Monocular & Binocular Pursuit in Patients



Monocular & binocular error differed for patients with non-overlapping scotomas, but not for controls or patients with binocular scotomas, Mann-Whitney U Test, $p<0.05$ (P3, P5-P7).

Inset: axes magnified for clarity.

Summary & Conclusions

- Gains in patients were abnormal (0.00-3.77) and varied with target direction.
- Patients exhibited more error between target and eye position than healthy controls.
- Binocular viewing reduced error only for patients with non-overlapping scotomas, but did not affect gain overall.

Reference: 1. Rashbass, C. (1961). The relationship between saccadic and smooth tracking eye movements. The Journal of Physiology, 159, 326–338.

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