

# Eye movements in reading drifting text.

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## Introduction

People are able to read drifting text relatively efficiently (e.g. Legge et al., 1985). Previous studies have indicated that reading horizontally drifting text is accomplished by means of a combination of slow tracking eye movements and fast saccades (Buettner et al., 1985; Legge et al., 1985).

In the present study we set out to investigate the control of eye movements both in the case of text drifting horizontally and in the case of text drifting vertically, i.e. parallel and orthogonal to the reading direction, respectively.

## Method

**Text:** 70 one-paragraph newspaper article excerpts (mean length 401 char). **Eye Tracking:** EyeLink 1000. **Display:** Arial font, 20 pts/0.7°, black on white, CRT with 100Hz refresh rate. **Procedure:** true/false questions followed each item. **Participants:** 24 (12 for each drifting direction condition).

### Horizontally Drifting

#### Drifting text

Participants triggered trial start with central fixation.

The text drifted rightwards at either 10.57 or 14.1°/s.

#### Static text

Participants triggered trial start with fixation on the left of the screen.

The excerpts were cut in lines of up to 50 chars. Each line was shown in the middle of the screen. Reading time was limited to 0.044 s per char.

#### Drifting text

Participants triggered trial start with fixation on top-left or bottom-left of screen.

The text drifted upwards or downwards at either 3.52 or 7.05°/s.

The text was split into lines of up to 38 and up to 18 chars for the two speeds, respectively.

Inter-line distance was 5.64°.

#### Static Text

Participants triggered trial start with fixation on top left of screen. Up to four lines were presented at the same time. Reading time was limited to 0.044 ms per char.

### Vertically Drifting

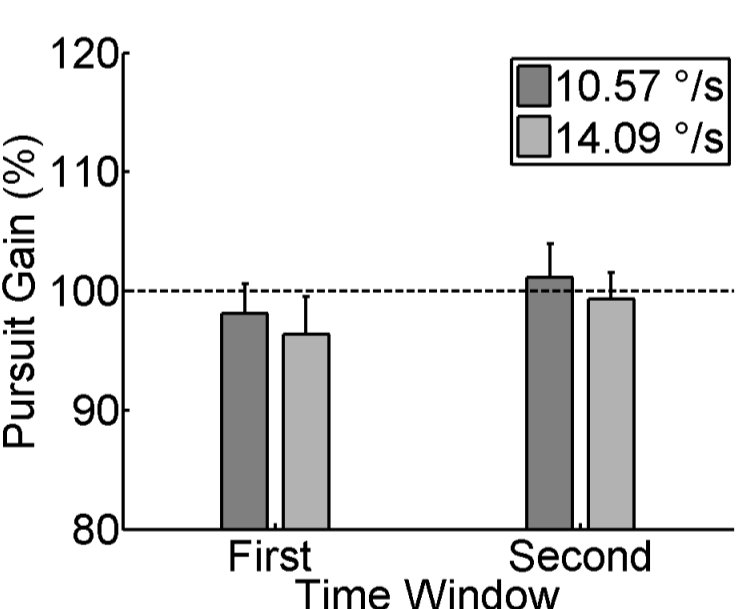
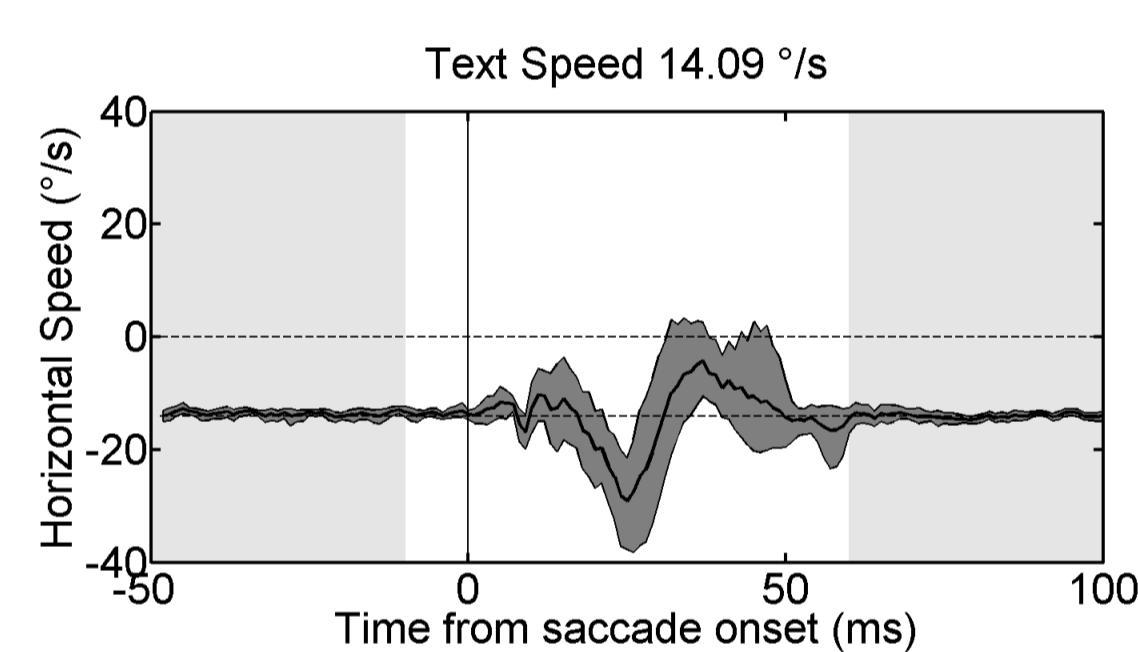
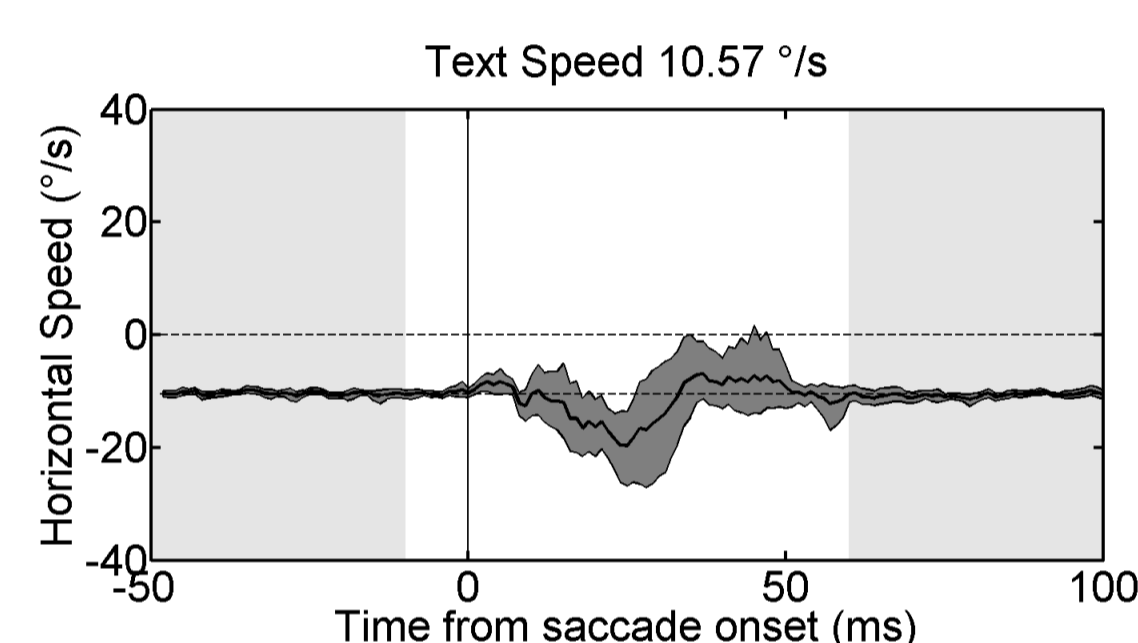
## Results

In general, all participants' eye-movement tracks from the drifting text blocks were corrected by subtracting the corresponding track from the static text blocks. In the case of saccade-triggered epochs, saccades of comparable amplitude were selected, in the case of fixation-triggered epochs, fixations of comparable duration were selected.

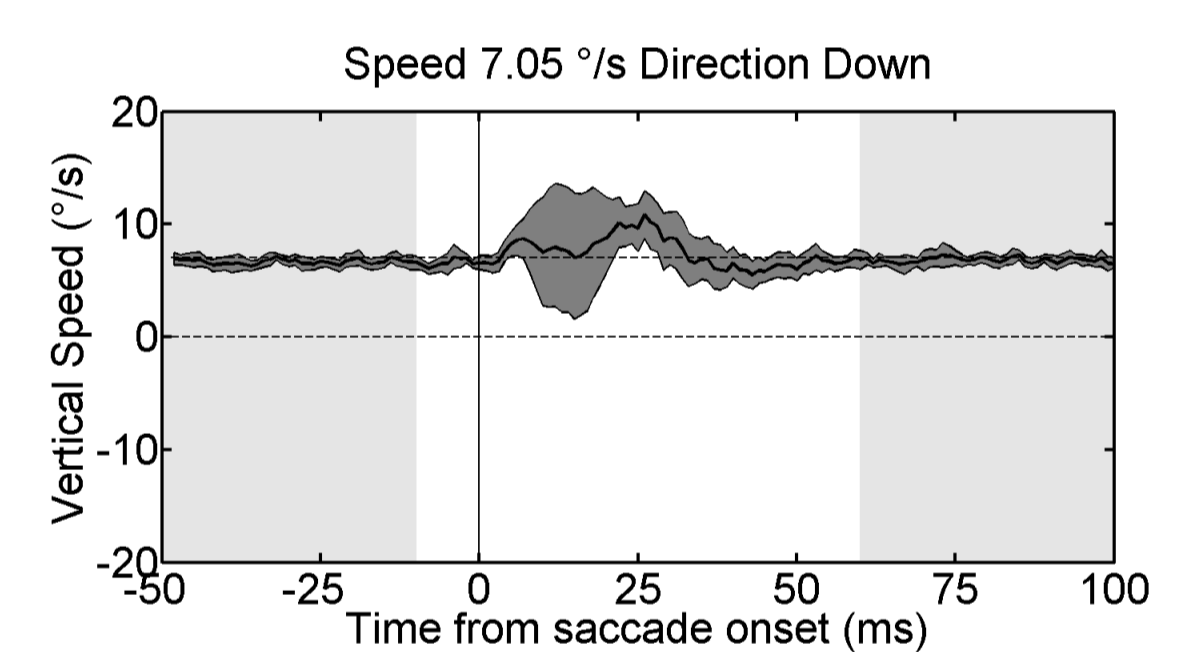
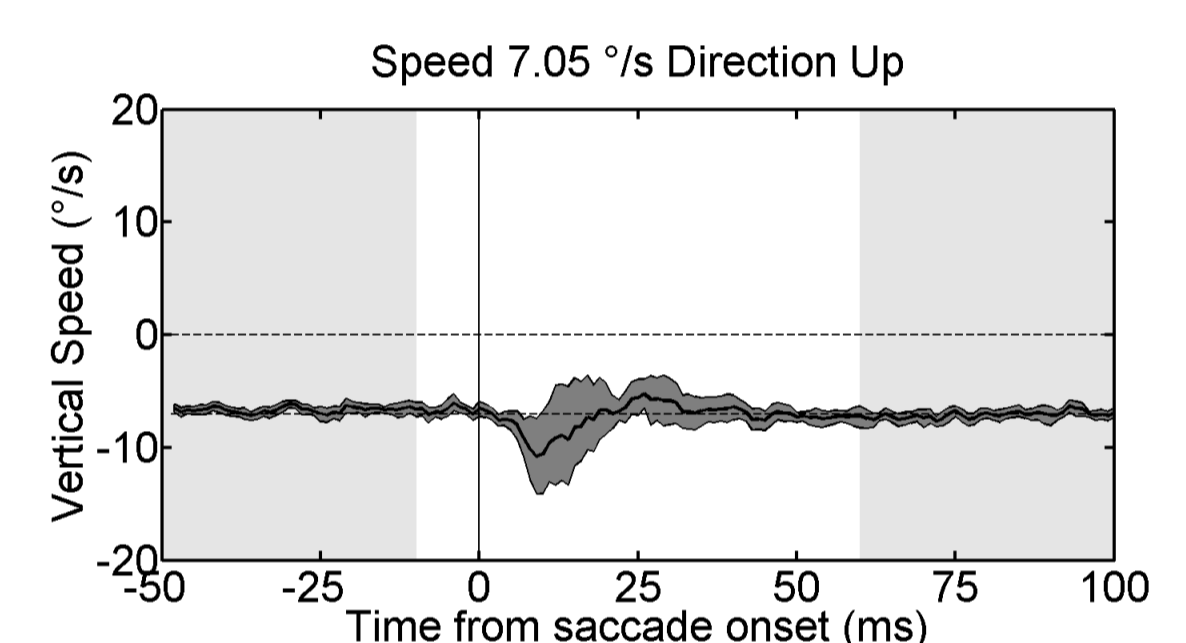
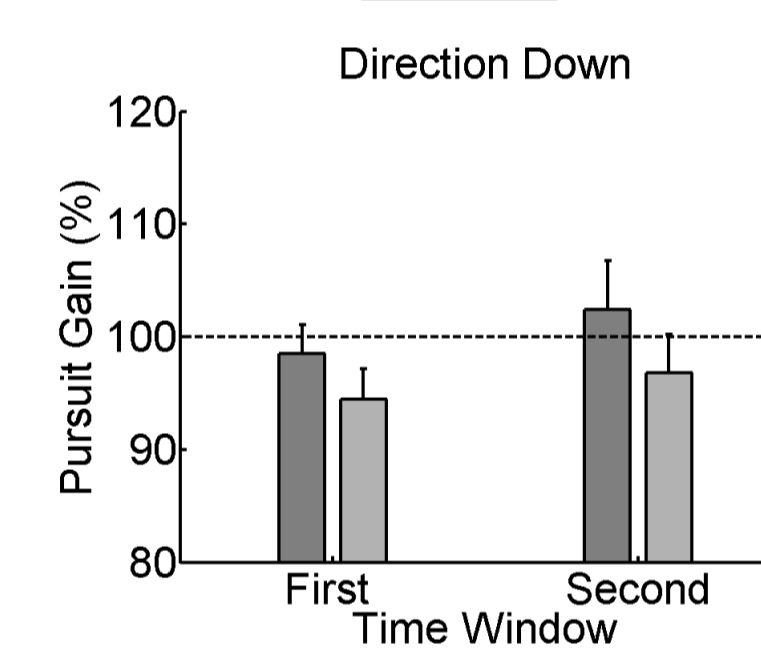
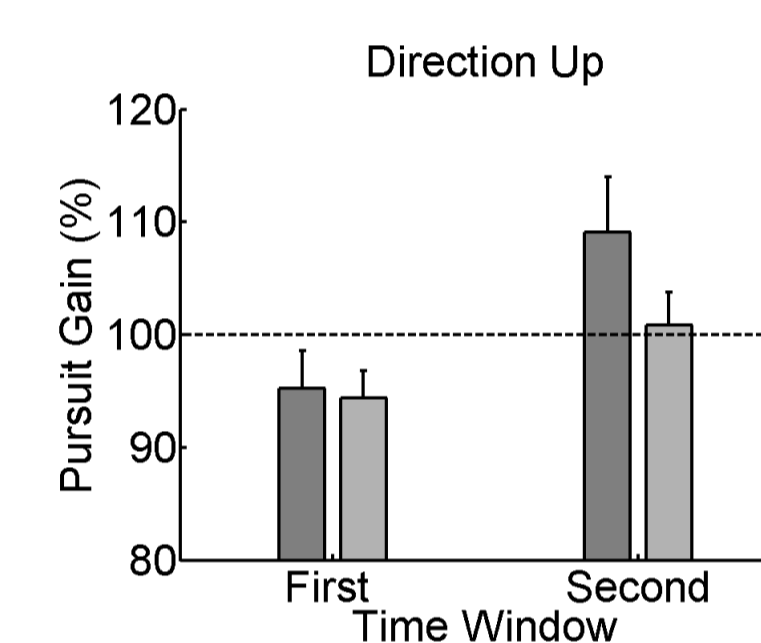
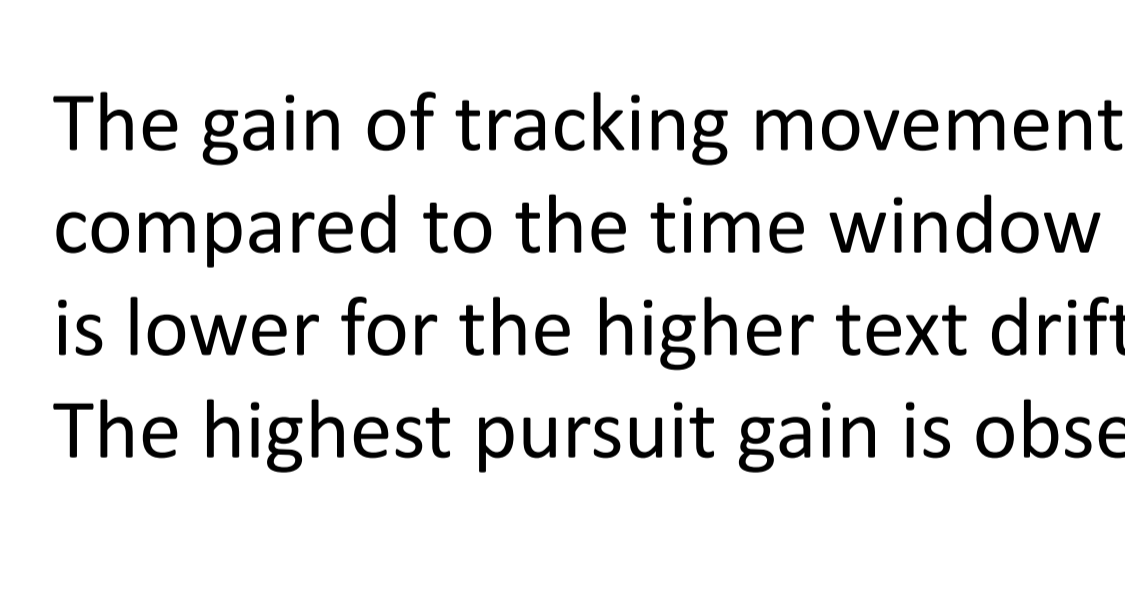
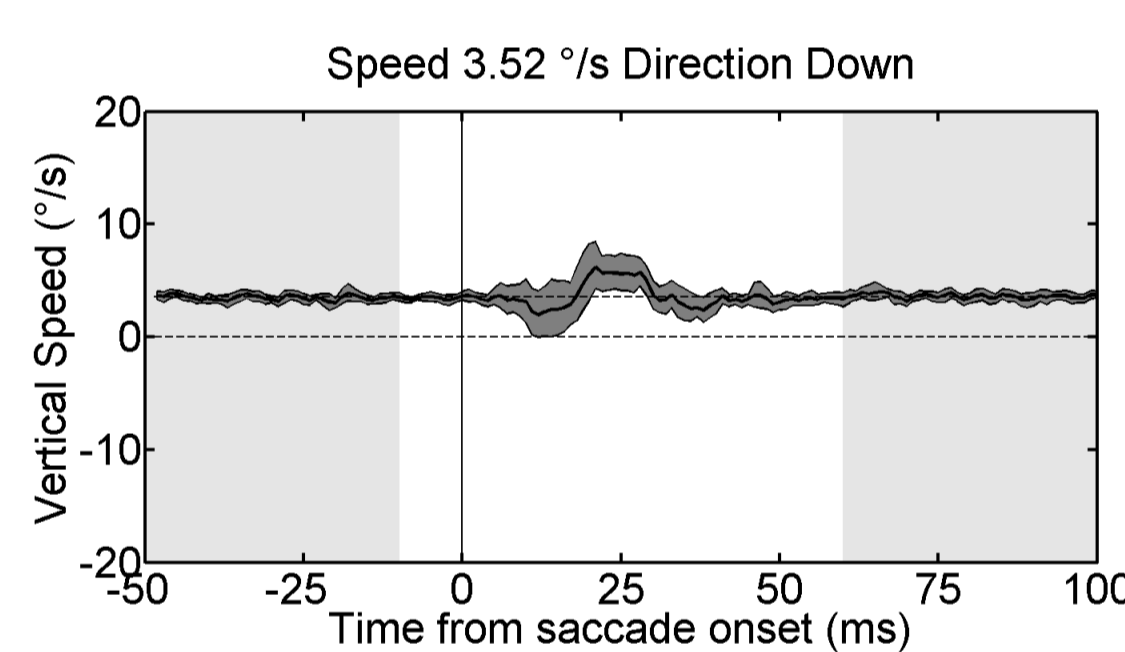
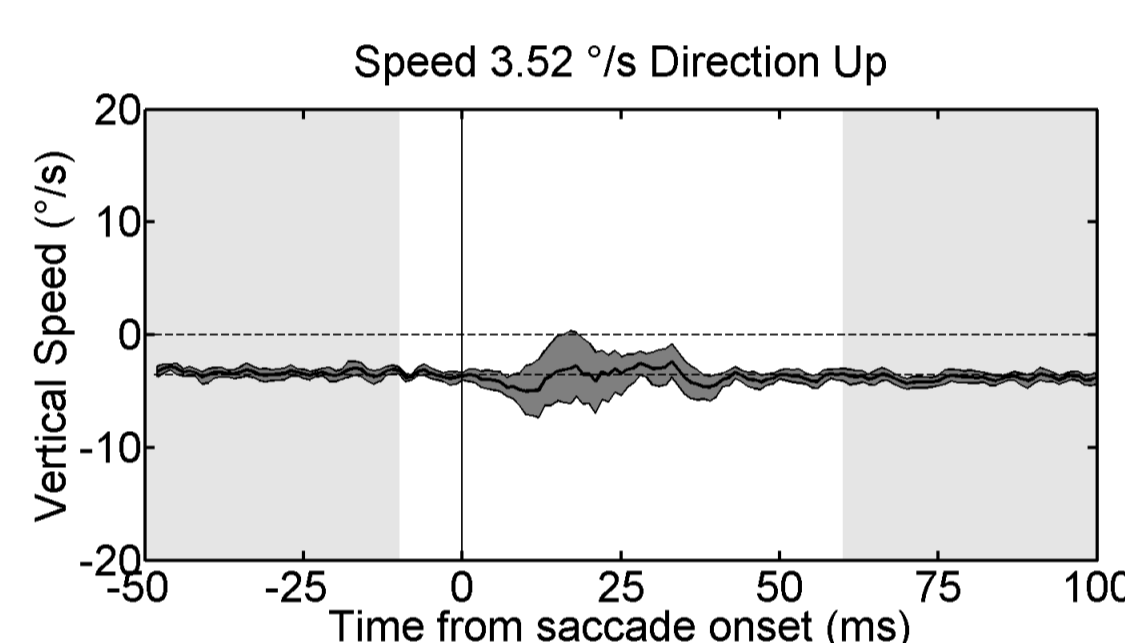
### Horizontally Drifting

#### Saccade-triggered Epochs

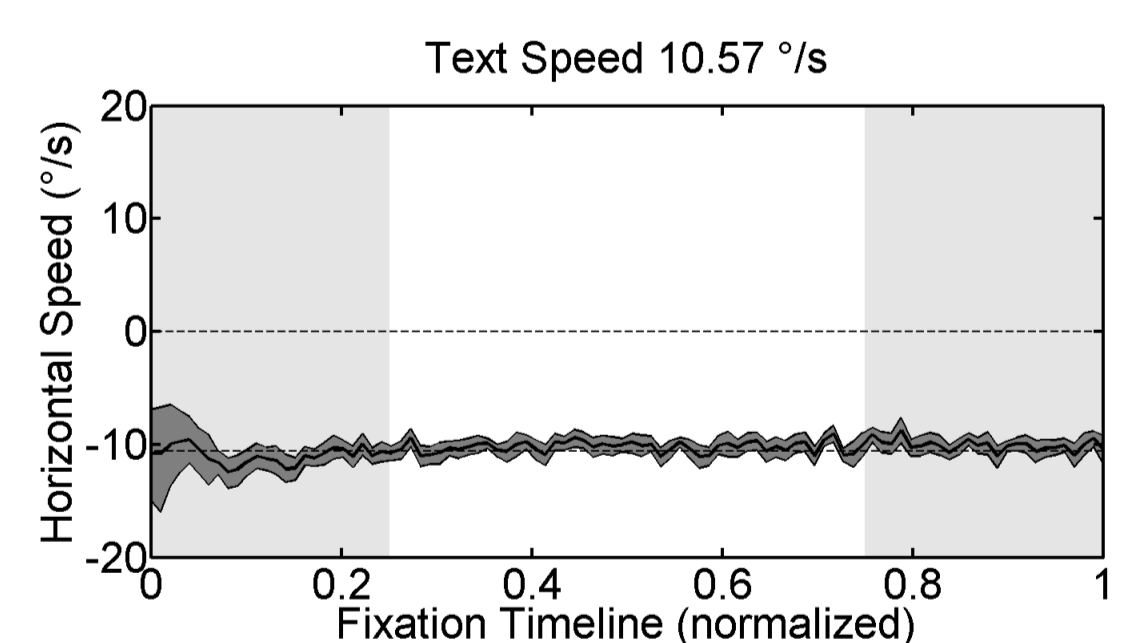
### Vertically Drifting



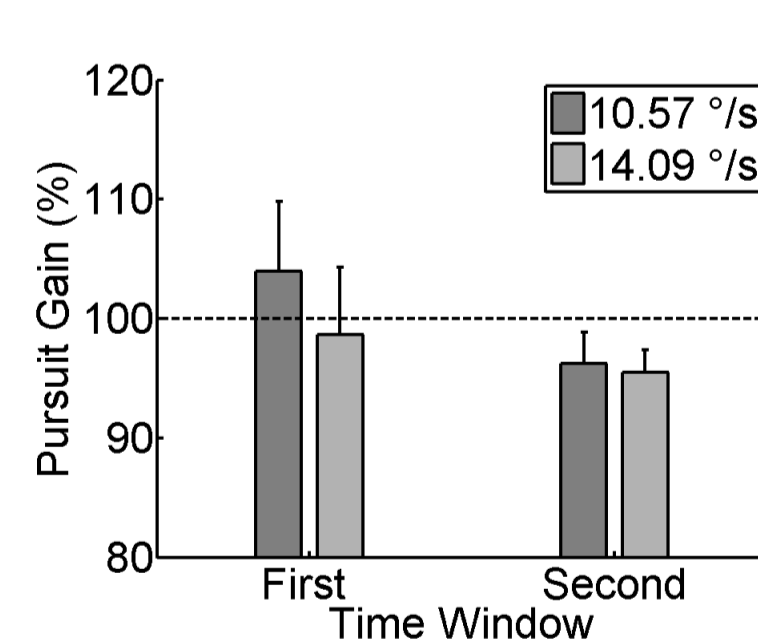
The pursuit gain is quite variable between observers during the saccade, nevertheless the data are suggestive of a biphasic increase-decrease pattern. We also analyzed the smooth pursuit gain in the time window preceding and following the saccade. In general, the gain of slow tracking movements is reduced with increasing text drift speed, but the effect of the time window is not significant.



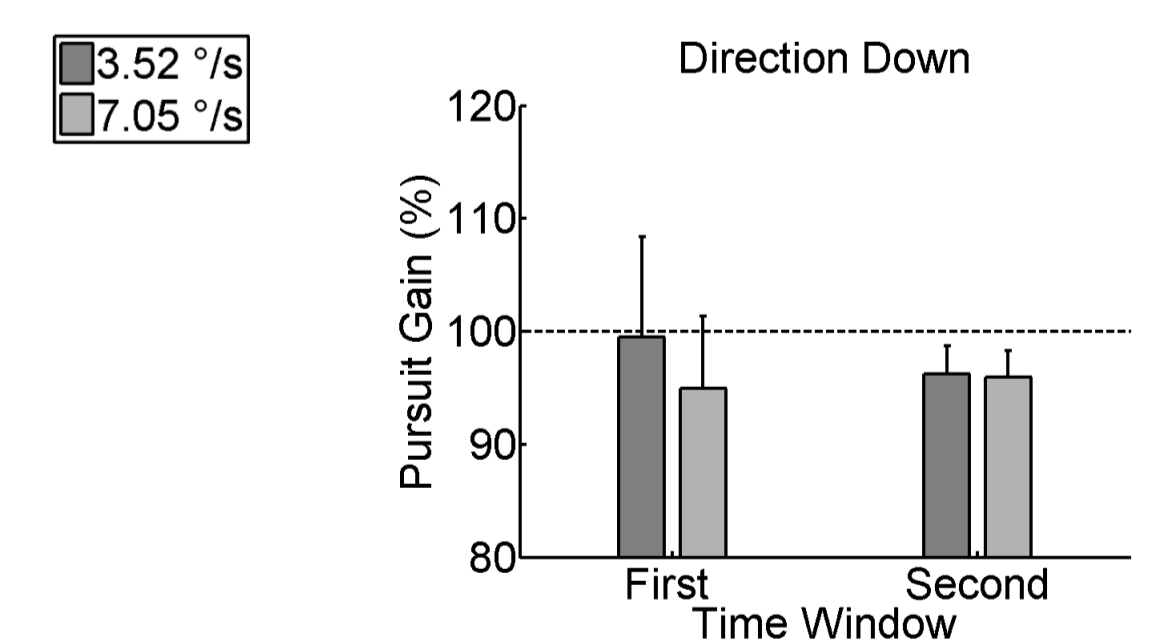
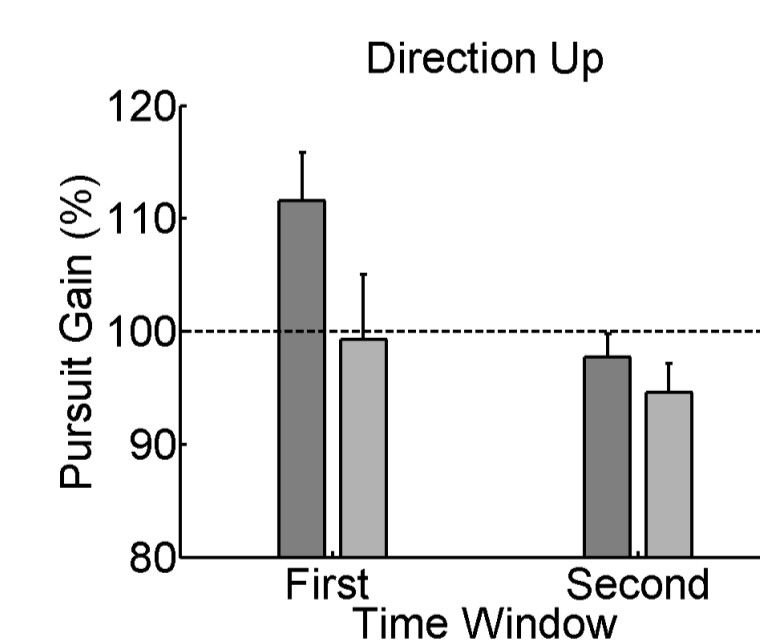
The gain of tracking movements is in general lower in the time window preceding the saccade as compared to the time window after saccade end. As in the case of horizontally drifting text, the gain is lower for the higher text drift speed. The highest pursuit gain is observed after saccades with text drifting upwards.



Fixation-triggered epochs show the opposite pattern of tracking gain modulation as compared to saccade-triggered epochs.



#### Fixation-triggered Epochs



As in the case of horizontally drifting text, the gain modulation of tracking movements during fixations mirrors the one observed across saccades.

## Conclusion

The data confirm the previous reports showing that reading drifting text is performed with a combination of smooth tracking movements and fast saccadic movements (Buettner et al., 1985; Legge et al., 1985).

In order to investigate the integration of slow and fast eye movements we calculated the gain of the tracking movement in peri-saccadic time windows.

Clearly the gain of tracking movements is more variable during saccades, but, especially in the case when the tracking and saccadic movements are almost orthogonal (vertically drifting text), it is not reduced. This indicates that the oculomotor system targets the point where the to-be-fixated text part will be at saccade landing rather than its pre-saccadic position and is consistent with the observation that target motion is taken into account for saccadic programming during smooth pursuit (Kim et al., 1997).

Moreover, a limited but consistent increase in tracking gain was observed across saccades in the case of vertically drifting text. Such an effect was less evident in the case of horizontally drifting text (where the tracking and saccadic eye movements had opposite directions). This result parallels the post-saccadic enhancement of smooth pursuit eye movements described by Lisberger (1998).

## References

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- Kim, C. E., Thaker, G. K., Ross, D. E., & Medoff, D. (1997). Accuracies of saccades to moving targets during pursuit initiation and maintenance. *Experimental Brain Research*, 113, 371-377.
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