# Gaze-direction effects on drivers' abilities to steer a straight course

Wilson O Readinger[1,2], Astros Chatziastros[1], Douglas W. Cunningham[1], Heinrich H. Bülthoff[1], & James E. Cutting[2]

MAX-PLANCK-GESELLSCHAFT

MPI FOR BIOLOGICAL CYBERNETICS

1. Max-Planck Institute for Biological Cybernetics, Tübingen
2. Cornell University Dept. of Psychology, Ithaca, USA

## Introduction

Advice given to individuals learning to ride horses[1], ride a motorcycle[2], and race automobiles[3], provide anecdotal evidence for the phenomenon of navigation, or heading control, being influenced by gaze-direction. The present study provides systematic evidence for this effect in a realistic driving simulation.

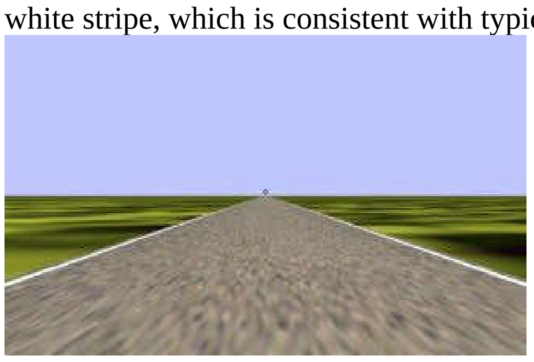
Specifically, it is suggested that direction of travel tends toward the direction of gaze. Many behavioral experiments dealing with human navigation, however, assume that first a goal is chosen in the environment, and subsequently people look in the direction of their travel, in order to avoid obstacles or evaluate progress. Here, we examine the issue from the reverse viewpoint, in order to determine to what extent drivers will "go where they look".

Based on this anecdotal evidence, as well as recent experimental data for walkers[4], this potential phenomenon could be explained in several different ways:

- as an effect of body/head position associated with eccentric gaze
- as a result of attentional factors based on the location of fixation
- as a product of retinal flow information and specific task demands

## Methods

Participants were tested in a 180-degree horizontal-FOV projection theater. They drove down a perfectly straight road (7.5 meters in width) at a constant speed of approximately 30mph, using a custom-designed forced-feedback steering-wheel. The street and ground plane were textured and separated by a white stripe, which is consistent with typical road-construction standards.



A Landolt-C figure was presented in order to ensure fixation. During the first 5 seconds of each trial, the figure appeared in the center of the screen. After that, it moved to an eccentric position and began to randomly rotate.

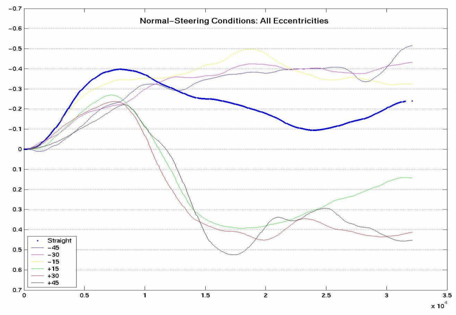
Subjects responded (by pressing a button on the steering wheel) when the figure was in a particular orientation (roll rotation of either 0, 90, 180, or 270 degrees). Trials in which subjects did not respond quickly to the correct orientation indicated a lack of fixation at the appropriate eccentricity, and were therefore excluded from the analyses.

Seven eccentricities were used in these experiments: 15, 30, and 45 degrees left and right of center screen, and 0. Each participant saw each eccentricity 7 times during the course of the experiment. Instructions were simply to drive down the center of the road and fixate the C-figure.

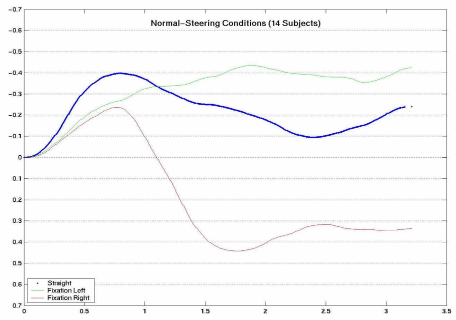
We present here data from 4 different conditions: (1)unrestricted head-movements, (2)head-movements restricted using a chin-rest, (3)reverse-steering, and (4)no forward movement.

## Results

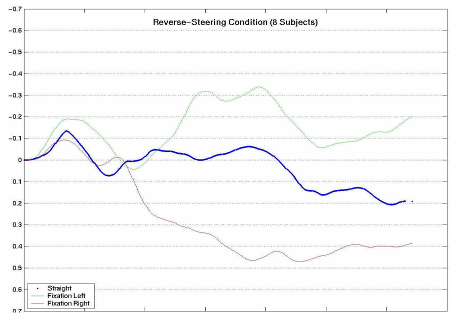
Throughout the 30 seconds of each trial, lateral position on the street was measured. Results from the unrestricted head-movement (1) and chin-rest (2) conditions were similar, and were therefore collapsed (henceforth, "normal steering") in the figures and analyses that follow.



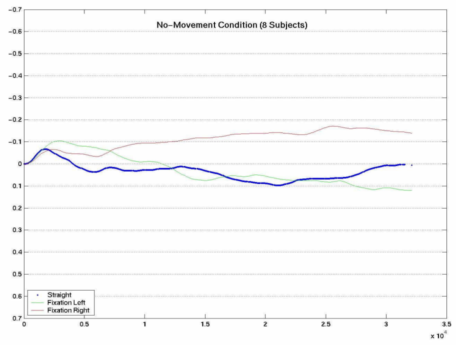

- Each eccentricity of the fixation figure is represented by a unique color.
- No significant differences were found within left-looking fixations (e.g., -30 and –45) or right-looking fixations.
- Conditions will be collapsed into simply "Left" and "Right" in further plots.




- Direction of gaze was found to significantly effect lateral position on the street.
- Looking-left differed from looking-right, and both differed from looking straight ahead, ($p<0.01$).




- Drivers were trained to steer in reverse (steering left led to movement right & vice versa), then completed the experiment.
- The trend to *drive* in the direction of gaze remains, although steering is now in the direction *opposite* of fixation.




- Drivers completed the same task, except without any forward movement through the environment.
- The trend to drive in the direction of gaze disappears. Furthermore, gaze-eccentricity effects are significant in the opposite direction, ($p<0.01$).

## Conclusions/Discussion

The tendency of drivers to steer in the direction of their gaze was confirmed. However, the reverse-steering condition suggests that this steering behavior is artifactual; drivers *head* in the direction of their gaze. Furthermore, this effect is not an effect of an attentional expansion on the side of the road where fixation is located, as indicated by the condition without forward movement.

These data suggest that drivers are behaving in a way that allows them to achieve a visual effect of the retinal flow in this environment. Gaze-eccentricities of as little as 15 degrees are sufficient to induce significant (and potentially practically important) effects on heading control.

## References

1 Morris, G.H. (1990). *Hunter seat equitation* (3rd ed.). New York: Doubleday.
2 Motorcycle Safety Foundation. (1992). *Evaluating, coaching, and range management instructor's guide*. Irvine, CA: Author. 1992.
3 Bondurant, R. & Blakemore, J. (1998). *Bob Bondurant on high performance driving*. Osceola WI: Motorbooks International.
4 Cutting, J.E. & Readinger, W.O. (*Submitted*). Walking, looking to the side, and taking curved paths.

*** For related work, see Chatziastros & Bülthoff: Handlung 17**

Supported by the J. William Fulbright-Kommission

wil@kyb.tuebingen.mpg.de

http://www.kyb.tuebingen.mpg.de/bu/