Gaze-eccentricity effects on automobile driving performance - *or* - Going where you look

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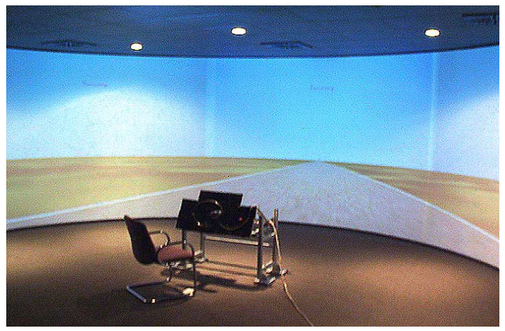
Introduction

Advice given to individuals learning to ride horses[1], ride a motorcycle[2], and race automobiles[3], provides anecdotal evidence that navigation and heading control are influenced by gaze-direction. In this study, we present systematic effects of direction and extent of gaze-eccentricity on steering in a realistic driving simulation.

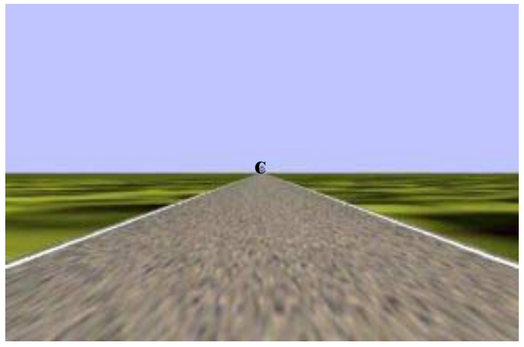
Specifically, it has been suggested that direction of travel is biased toward the direction of gaze. Many behavioral experiments dealing with human navigation, however, assume that first a goal is chosen in the environment, and subsequently people look in the direction of their travel, in order to avoid 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".

Methods



Participants were tested in a 180-degree horizontal-FOV projection theater. They drove on a perfectly straight road (7.5 meters wide) at a constant speed of 72 km/h, using a forced-feedback steering-wheel.

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 one of seven eccentric positions and began to randomly rotate.



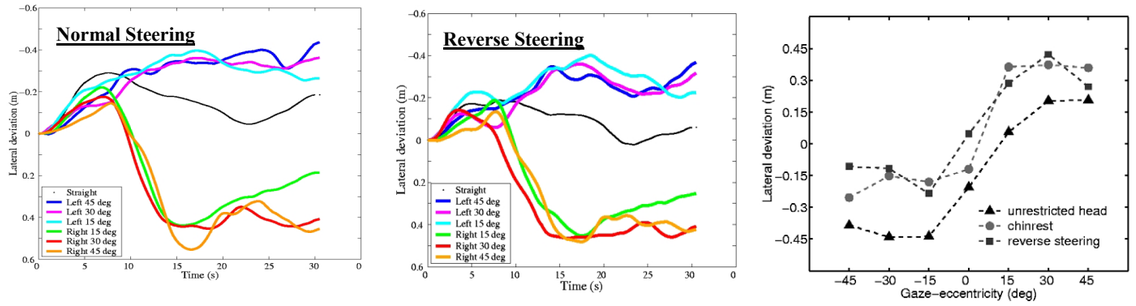
Subjects responded (by pressing a button on the steering wheel) when the figure was in a particular orientation (roll position of 0, 90, 180, or 270 degrees). Trials in which subjects did not respond quickly to the correct orientation indicated a lack of fixation at the appropriate eccentricity, and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

Eccentricities of fixation were 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.

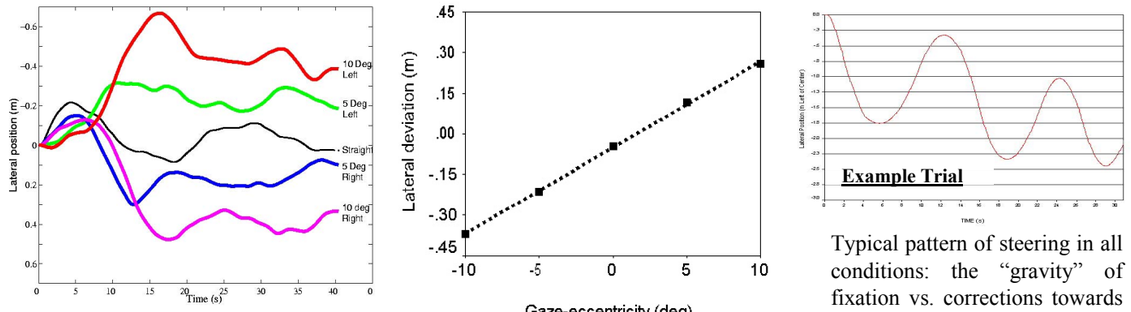
In order to study the effects of eye position and separate these from head position and changes in body posture, the following conditions were carried-out:
(1) unrestricted head-movement;
(2) head-movements restricted with a chin-rest and head-strap;
(3) steering control reversed (i.e., turning the wheel to the left led to movement to the right, and vice versa).
In another unrestricted head-movement condition, smaller eccentricities of 5 and 10 degrees were viewed.

Results

Side of gaze, but not size of the gaze-eccentricity, is significant in conditions with normal steering, a chin-rest, and reverse steering, ($p<0.01$). Furthermore, the same trend is reliably present in each case.



With smaller gaze-movement angles, the effect is significant not only for side of fixation, but also between eccentricities ($p<0.01$), and linear. At approximately 15 degrees of eccentricity from straight ahead, saturation is reached in terms of lateral deviation from the center of the street.



Typical pattern of steering in all conditions: the "gravity" of fixation vs. corrections towards center yield a sinusoidal pattern

Conclusions/Discussion

The tendency of drivers to navigate in the direction of their gaze was confirmed, even at eccentricities as small as 5 degrees from straight ahead. However, the *steering* behavior appears to be artifactual; drivers *head* in the direction of their gaze, even when this means turning the steering wheel in the opposite direction. Similarity of the chin-rest and reverse-steering condition with the normal, free-movement condition suggest that the effect cannot be explained as a tonic reflex, but indicates a perceptual effect that the driver is attempting to achieve.

References

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4 Cutting, J.E. & Readinger, W.O. (*Submitted*). Walking, looking to the side, and taking curved paths.

FULBRIGHT
Supported by the J. William Fulbright Commission
New York, NY, USA & Berlin, Germany
Vision Sciences Society, Sarasota, May 2001

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