



# EVEN EXPERIENCED DRIVERS HAVE THE WRONG CONCEPT ABOUT HOW TO CHANGE LANES

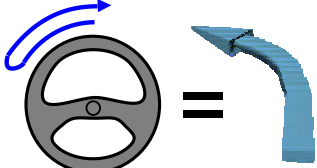
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## 1 INTRODUCTION

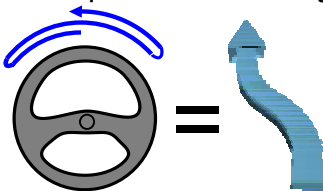
Although steering a vehicle requires a great deal of visual information before its initiation, it may be the case that due to anticipation and the highly practised nature of steering, experienced drivers require no further visual feedback once the manoeuvre has been initiated. Indeed, several researchers have proposed that some steering manoeuvres, including lane changing, can be executed without visual feedback i.e. 'open-loop' (McRuer et al., 1977; Godthelp, 1985; Schumann et al., 1993), the validity of which we investigate in this work.

To change lanes without visual feedback the appropriate steering movement must presumably be stored as a complete motor program. When asked to demonstrate the steering wheel movements corresponding to a lane change, 23 out of 24 subjects acted out the following, incomplete pattern of steering wheel movements:



Turning the steering wheel to the left and then back to the central position results in a change of heading direction, rather than a lane change.

The above example represents the first phase of the complete lane-change steering manoeuvre. In the second phase, a further turn in the opposite direction is required before recentering the steering wheel:



This pattern of steering movements results in a shift of lateral position, ultimately regaining the initial heading direction.

If the complete lane-change manoeuvre is stored as a predefined motor program\*, then under conditions without visual feedback the resulting heading direction should deviate only **randomly** from the initial heading. If, however, the program requires visual feedback for its completion, a **systematic** deviation from the initial heading would be expected.

## 2 METHODS

Five licenced drivers drove with constant velocity – 64.8 km/h (18 m/s) – in a simulated environment projected on a 180° screen. Natural haptic feedback was provided using a forced-feedback steering wheel. Subjects performed the required lane-changing manoeuvre on a straight motorway. After performing the manoeuvre once in daylight, subjects drove into a dark tunnel and were asked to change lanes again, with occluded vision, i.e. without visual feedback.

Travelling in daylight



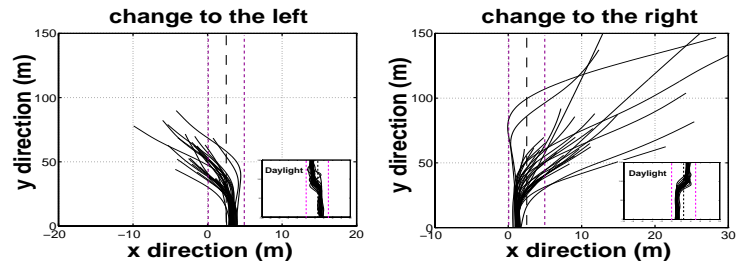
Entering the tunnel



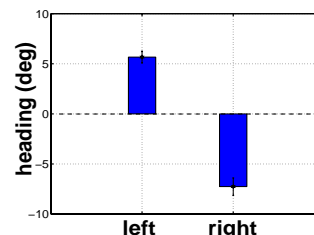
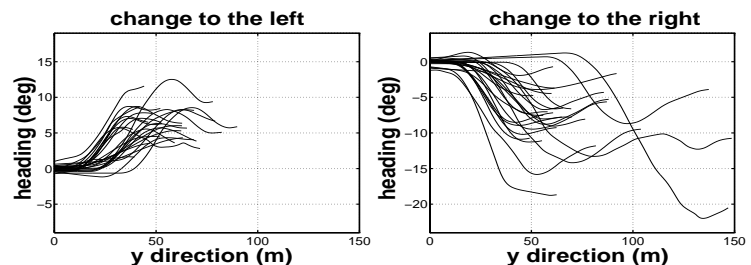
In the occluded condition, no feedback about the accuracy of the manoeuvre was given to prevent learning effects. After terminating the manoeuvre without visual feedback the subjects were asked to release the steering wheel. A total of ten trials were run per subject, resulting in 5 lane changes to the left and right.

## 3 RESULTS

Without visual feedback lane changes both to the left and to the right resulted in a systematic deviation from the straight course of the road. Here the road runs parallel to the y-axis.



The final heading direction deviated from the direction of the road (heading = 0°), exposing a failure to complete the steering manoeuvre.



The subjects' final heading was consistently biased in the direction of the initial lane change, and differed significantly from the line of the road ( $p < 0.001$ ).

## 4 DISCUSSION

● Despite the highly practised nature of the lane-change manoeuvre, drivers are not able to generate the appropriate steering movement without visual feedback. Therefore, the whole lane-changing manoeuvre cannot be considered as an open-loop process.

● Although a lane change can be initiated without visual feedback, the second phase of the lane-change manoeuvre (straightening the car) does require feedback.

● Intuitive knowledge about the relationship of the steering movements and the resulting vehicle's motion is incomplete, revealing a misconception about the dynamics of vehicles.

## 5 REFERENCES

- McRuer, D.T., Allen, R. W., Weir, D. H. & Klein, R. H. (1977). New results in driver steering control models. *Human Factors*, 19, 381 – 397.
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- ★ *More on visuo-motor programs at ECVP '97*: "Can learning on grasp facilitate novel grasps ?" M. O. Ernst, H.A.H.C. van Veen & H. H. Bülthoff: Poster Session Thursday 28.8.97, No. 61.